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# SOURCES OF AREOGRAPHIC COORDINATES, 1877-1907

G. de Vaucouleurs and R. Wright



UNPUBLISHED PRELIMINARY DATA



PREPARED FOR:
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The RAND Corporation
SANTA MONICA • CALIFORNIA

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## PREFACE

Features visible on the surface of Mars have been recorded at nearly every opposition since 1877, first from visual observations, and more recently by both visual and photographic techniques. Many observers have tried to determine the latitude and longitude of the points observed.

The senior author of this report has been engaged for a number of years (under the support of various sponsors) in a project to collect and analyze all available Mars observations in a systematic way, with the ultimate objective of producing as accurate and consistent a map as statistical methods will permit. This goal is still in the future. However, the present report records an important stage in the work. It lists for the oppositions of 1877 to 1907 those measurements that have appeared in the literature and that represent positively identifiable Martian features. It also cross-indexes the features measured more than once.

The form of the report follows closely the form established by the previous report, which covered the period 1909 to 1954. Thus it includes a set of maps that present graphically the information given in the cross-index, and a detailed discussion of corrections and interpretations that the present authors have applied to the published data. It must be emphasized that the present report is neither a source of data nor a complete study or commentary in itself. Strictly, it is a progress report, and it is most meaningful in the context of the larger project of which it depicts one part.

This portion of the work was supported under Contract NASr-21(04) with the National Aeronautics and Space Administration. The senior author, a consultant to The RAND Corporation, is a professor in the Department of Astronomy at the University of Texas.

16765

## ABSTRACT

All published areographic coordinates for the oppositions of 1877 through 1907 were checked, corrected and cross-identified after a thorough search for usable data in the literature. Altogether 380 points on Mars' surface recorded by 17 observers are listed, with notes on errors of measurement or identification in the original sources; individual observer's maps and a basic master map are given.

This report is sequel to and homogeneous with our earlier publication Sources of Areographic Coordinates, 1909--1954 (Harvard College Observatory Report 2, ARDC Contract AF 19(604)-7461, AFCRL 257.)

## ACKNOWLEDGMENT

The painstaking work of Mrs. L. Hudson in preparing the extensive maps presented here is gratefully acknowledged.

CONTENTS

# I. INTRODUCTION

A comparison of existing maps of Mars and lists of areographic coordinates betrays discrepancies of 5 to 10 degrees; such confusion clearly does not meet the requirements of the program for planetary exploration. At present there is no set of homogeneous accurate, areographic coordinates in a well-defined system; seasonal and secular variations of the topography add to the confusion.

In 1958 a program for the precision mapping of Mars was started at Harvard Observatory; successive steps in this continuing program were summarized at the Liège Symposium (1962) in a report,[1] in which other references may be found.

The first step in the program was to search the existing material on areographic coordinates published since 1877, when G. V. Schiaparelli opened the "modern" era of areographic studies. In a report[2] on sources of areographic coordinates, published in 1961, we have listed the visual and photographic material of the three cycles of oppositions from 1909 to 1954.

Completing that first step, the present report covers in homogeneous fashion the two cycles from 1877 to 1907.* In preparing it, we have reviewed all the lists of areographic coordinates published during that period. Here we present charts which symbolize the data worth keeping for further analysis. Altogether 34 different sources are available for the observations throughout the two cycles, during which 17 observers contributed all together 789 values (from over 2,500 independent measurements) for 380 points.

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*We refer to the period as ending with the 1907 opposition although no published coordinate lists were found for 1905 and 1907. A map based on Lowell's photographs of 1907 was published by Sormano (Ref. 38), but we have been unable to locate the corresponding list of coordinates which Antoniadi (Ref. 37) mentions (without bibliographical reference) as having "seen."

As in the previous report, our objectives here are to present a homogeneous list of this scattered and little known, but valuable material, and to cross-identify the points measured.

Section II of this report gives a tabular summary of the material, citing the sources, listing observers, instruments, number of measurements, types of measurements and coordinate systems, period of observations, range of phase angle, and heliocentric longitude.

Section III consists of a series of maps showing the approximate locations of the points measured by each observer at each opposition, preceded by extensive notes as to mis-identifications, errors, misprints, etc., disclosed by a detailed critical study of the original sources. It is not intended, nor is it possible to locate these points with accuracy at this stage of the project, but the loose-leaf map mentioned in the paragraph below serves to relate each point approximately to other geographical features of Mars.

Section IV includes an outline map of the topography (with a second loose-leaf copy for use with the maps of Sections III and IV). It also presents a map in which are combined all well identified points to which Key Map List (KML) numbers were assigned. A double-entry table with continuous KML number cross identifies the individual maps of Section III and the combined maps.* We have attempted in another table to show the identification of the KML numbers of this report with the VML (and PML) numbers used in Ref. 2 for the period 1909--1954. Identification is not always certain because of topographical changes and differences in the areographic coordinate systems used in the two periods.

The maps are reproduced on the same scale as those in Ref. 1.

The coordinates themselves and other relevant data have been transferred to punched cards for statistical analysis.

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*In this report, quotations of pre-Schiaparellian nomenclature will be followed by the equivalent modern name in brackets; most of these modern names were introduced by Schiaparelli, but a few are due to Lowell, Cerulli or Antoniadi (Ref. 37). The IAU map and simplified nomenclature are not suitable for a detailed study of areographic places.

## II. SOURCES AND THE NATURE OF THE SOURCE MATERIAL

Table 1 identifies the observer and the year of observation with the reference source used and the code number and abbreviation used to identify the given observations in this report.

Tables 2a and 2b give, for the individual sources and for each of the two cycles, 1877--1890 and 1892--1907:

(a) The year, the date, and the heliocentric longitude, $\eta$, of the opposition; the date, the heliocentric longitude, and the phase angle in longitude, $\Delta A$ of the first and last observations. (The mean values of $\eta$ and $\Delta A$ for the approximate middle of the observing period are recorded on the punched cards.)

(b) The observer's code designation (from Table 1), the location, the aperture, and the type of telescope used (R = refractor; r = reflector); the total number of points for which coordinates are given; and the total number and type of individual measurements on which these coordinates are based. (All measurements were visual. D = drawings; T = transits; M = micrometers.)

The reference system used for the longitude of the central meridian, $\omega$, and for the position angle, $\eta$, of the axis of rotation is noted. (M = Marth's ephemeris, occasionally corrected as in B for Bakhuysen, C for Crommelin's and W for Wislicenus.* When the pole of rotation was determined by the observer from internal evidence, it is noted north or south according to whether the micrometer wire was placed through the center of the north or the south polar cap to define the central meridian.

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*In the period 1877--1907, the physical ephemeris of Mars was not computed by the national almanacs; observers had to use ephemerides from a variety of sources. The sources of the physical ephemeris of Mars are to be the subject of a future report.

Table 1

IDENTIFICATION AND CODING OF SOURCES

| Code | Observer and Year | Bibl. Ref. | Abbreviation |
|---|---|---|---|
| 8.01 | Dreyer, 1877 | 20 | DR 77 |
| 8.02 | Green, 1877 | 20 | GN 77 |
| 8.03 | Lohse, 1877 | 20 | LH 77 |
| 8.04 | Niesten, 1877 | 20 | NI 77 |
| 8.05 | Schiaparelli, 1877 | 4, 6 | SC 77 |
| 8.06 | Winnecke, 1877 | 10 | WN 77 |
| 8.07 | Burton, 1879 | 5 | BU 79 |
| 8.08 | Lohse, 1879 | 7 | LH 79 |
| 8.09 | Niesten, 1879 | 12 | NI 79 |
| 8.10 | Schiaparelli, 1879 | 6 | SC 79 |
| 8.11 | Niesten, 1881 | 13 | NI 81 |
| 8.12 | Denning, 1884 | 23 | DE 84 |
| 8.13 | Knobel, 1884 | 8, 9 | KN 84 |
| 8.14 | Lohse, 1884 | 16 | LH 84 |
| 8.15 | Lohse, 1886 | 16 | LH 86 |
| 8.16 | Schiaparelli, 1886 | 24 | SC 86 |
| 8.17 | Lohse, 1888 | 16 | LH 88 |
| 8.18 | Schiaparelli, 1888 | 24 | SC 88 |
| 8.19 | Wislicenus, 1888 | 11 | WS 88 |
| 8.20 | Wislicenus, 1890 | 11 | WS 90 |

Table 1 (Continued)

| Code | Observer and Year | Bibl. Ref. | Abbreviation |
|---|---|---|---|
| 9.01 | Lohse, 1892 | 19 | LH 92 |
| 9.02 | Pickering, 1892 | 38 | PI 92 |
| 9.03 | Williams, 1892 | 18 | WL 92 |
| 9.04 | Lowell, 1894 | 17, 22 | LW 94 |
| 9.05 | Cerulli, 1896 | 21 | CE 96 |
| 9.06 | Lowell, 1896 | 26 | LW 96 |
| 9.07 | Cerulli, 1899 | 25 | CE 99 |
| 9.08 | Denning, 1899 | 23 | DE 99 |
| 9.09 | Antoniadi, 1901 | 27, 34 | AN 01 |
| 9.10 | Graff, 1901 | 35 | GR 01 |
| 9.11 | Lowell, 1901 | 30 | LW 01 |
| 9.12 | Lowell, 1903 | 31 | LW 03 |
| 9.13 | Molesworth, 1903 | 32 | MO 03 |
| 9.14 | Antoniadi, 1903 | 29 | AN 03 |

T A B

OBSERVERS AND STATIONS FOR

| Code | Telescope | | Total | Measures | | Reference | | Year of Observation |
|---|---|---|---|---|---|---|---|---|
| | Location | Aperture | Points | Total | Type | ω | Pole | |
| DR 77 | Parsonstown | 36-in r | 5 | 8 | D | M+B | B | 1877 |
| GN 77 | Funchial | 13-in r | 9 | 23 | D | M+B | B | " |
| LH 77 | Potsdam | 5.5-in R | 4 | 18 | D | M+B | B | " |
| NI 77 | Bruxelles | 15-cm R | 3 | 9 | D | M+B | B | " |
| SC 77 | Milano | 21.8-cm R | 62 | 122+107 | M | M | M+3° | " |
| WN 77 | Strassburg | 6-in R | 1 | 2 | T | - | M | " |
| BU 79 | Loughlinstone | (a) | 31 | 106 | D | M | SPC | 1879 |
| LH 79 | Potsdam | 29.8-cm R | 4 | 22 | D | M | - | " |
| NI 79 | Bruxelles | 15-cm R | 58 | 200 | D | M+5° | - | " |
| SC 79 | Milano | 21.8-cm R | 106 | 374 | M | M+C | SPC | " |
| NI 81 | Bruxelles | 15-cm R | 19 | 45 | D | - | - | 1881 |
| DE 84 | Bristol | 10-in r | 1 | 4 | T | - | NPC | 1884 |
| KN 84 | Burton/Trent | 21-in r | 2 | 2 | T | M | - | " |
| LH 84 | Potsdam | 29.8-cm R | 19 | - | M,T | M | NPC | " |
| LH 86 | Potsdam | 29.8-cm R | 1 | 3 | T | M | NPC | 1886 |
| SC 86 | Milano | 18-in R | 2 | 2 | T | M | M | " |
| LH 88 | Potsdam | 29.8-cm R | 1 | 1 | T | M | NPC? | 1888 |
| SC 88 | Milano | 18-in R | 2 | 5 | T | M | M | " |
| WS 88 | Strassburg | 6-in R | 7 | 11 | M | M | W 1 | " |
| WS 90 | Strassburg | 6-in R | 14 | 19 | M | M | W 2 | 1890 |

(a) 6-in R, 8+12-in r

L E 2a

MARS OPPOSITIONS 1877--1907

| | Opposition | | | Initial Observation | | | Final Observation | | |
|---|---|---|---|---|---|---|---|---|---|
| Code | Date | $D_E$ | $\eta$ | Date | $\eta$ | $\Delta$ A | Date | $\eta$ | $\Delta$ A |
| DR 77 | Sep 5 | $-19.^{\circ}8$ | $343^{\circ}$ | Sep 7 | $344^{\circ}$ | $+ 1.^{\circ}$ | Oct 1 | $0^{\circ}$ | $+22.^{\circ}$ |
| GN 77 | " | " | " | Aug 21 | 334 | -15 | Sep 29 | 358 | +21 |
| LH 77 | " | " | " | Sep 8 | 345 | + 2 | Oct 15 | 8 | +31 |
| NI 77 | " | " | " | Aug 22 | 335 | -15 | Oct 13 | 7 | +29 |
| SC 77 | " | " | " | Sep 12 | 348 | + 6 | Nov 4 | 20 | +38 |
| WN 77 | " | " | " | Sep 10 | 346 | + 4 | Sep 11 | 347 | + 5 |
| BU 79 | Nov 12 | -13.3 | 50 | Oct 5 | 28 | -32 | Jan 5 | 78 | +35 |
| LH 79 | " | " | " | Sep 27 | 23 | -37 | Dec 17 | 69 | +27 |
| NI 79 | " | " | " | Oct 3 | 27 | -33 | Jan 26 | 89 | +39 |
| SC 79 | " | " | " | Sep 30 | 25 | -35 | Dec 27 | 74 | +32 |
| NI 81 | Dec 26 | +3.3 | 95 | Dec 12 | 88 | -13 | Mar 16 | 132 | +40 |
| DE 84 | Jan 31 | +15.8 | 132 | Feb 14 | 138 | + 9 | Feb 22 | 141 | +15 |
| KN 84 | " | " | " | Feb 6 | 134 | + 3 | Feb 17 | 139 | +12 |
| LH 84 | " | " | " | Dec 23 | 114 | -28 | Mar 30 | 158 | +33 |
| LH 86 | Mar 6 | +22.0 | 166 | Feb 2 | 152 | -25 | Mar 12 | 169 | + 5 |
| SC 86 | " | " | " | Apr 6 | 180 | +25 | Apr 7 | 180 | +25 |
| LH 88 | Apr 11 | +20.3 | 202 | May 2 | 212 | +18 | | | |
| SC 88 | " | " | " | May 30 | 225 | +34 | Jun 2 | 227 | +35 |
| WS 88 | " | " | " | May 2 | 183 | +18 | May 13 | 188 | +26 |
| WS 90 | May 27 | + 8.0 | 246 | Apr 12 | 223 | -27 | Aug 1 | 284 | +38 |

T A B

OBSERVERS AND STATIONS FOR

| Code | Telescope | | Total Points | Measures | | Reference | | Year of Observation |
|---|---|---|---|---|---|---|---|---|
| | Location | Aperture | | Total | Type | ω | Pole | |
| LH 92 | Potsdam | 29.8-cm R | 1 | 1 | T | - | SPC | 1892 |
| PI 92 | Arequipa | 12-in R | 1 | - | D | M | - | " |
| WL 92 | Brighton | 6.5-in r | 12 | 17 | T | M | SPC | " |
| LW 94 | Flagstaff | 18-in R | 36 | 79+45 | T,D | M | M | 1894 |
| CE 96 | Collurania | 15.5-in r | 62 | >127 | T,D | M | M | 1896 |
| LW 96 | Flagstaff | 24-in R | 82 | - | T,D | M | M | " |
| CE 99 | Collurania | 15.5-in r | 41 | 69+8 | T,D | C | C | 1899 |
| DE 99 | Bristol | 10-in r | 1 | 1 | T | - | NPC | " |
| AN 01 | Juvisy | 24-cm R | 9 | - | T | C | C | 1901 |
| GR 01 | Berlin | 12-in R | 15 | - | D | - | NPC | " |
| LW 01 | Flagstaff | 24-in R | 5 | >9 | T,D | C | C | " |
| LW 03 | Flagstaff | 24-in R | 59 | 197+? | T,D | C | C | 1903 |
| MO 03 | Trincomali | 12.8-in r | 72 | 542+60 | T,D | C | NPC | " |
| AN 03 | Juvisy | 24-cm R | 42 | - | T,D | C | C | " |

L E 2b

MARS OPPOSITIONS 1877--1907

| | Opposition | | | Initial Observation | | | Final Observation | | |
|---|---|---|---|---|---|---|---|---|---|
| Code | Date | $D_E$ | $\eta$ | Date | $\eta$ | $\Delta$ A | Date | $\eta$ | $\Delta$ A |
| LH 92 | Aug 4 | $-13.^{\circ}6$ | $312^{\circ}$ | Aug 11 | $317^{\circ}$ | $+ 4.^{\circ}$ | - | - | - |
| PI 92 | " | " | " | ? | - | - | - | - | - |
| WL 92 | " | " | " | Aug 20 | 322 | +12 | Oct 7 | $352^{\circ}$ | $+39^{\circ}$ |
| LW 94 | Oct 20 | -18.8 | 27 | Aug 20 | 322 | -40 | Nov 22 | 46 | +25 |
| CE 96 | Dec 11 | - 3.1 | 80 | ? | - | - | ? | - | - |
| LW 96 | " | " | " | Jul 31 | 4 | -46 | Jan 17 | 98 | +23 |
| CE 99 | Jan 18 | +11.6 | 118 | Dec 11 | 101 | -27 | Mar 16 | 170 | +32 |
| DE 99 | " | " | " | Mar 7 | 166 | +28 | - | - | - |
| AN 01 | Feb 22 | +20.4 | 153 | Oct 12 | 92 | -34 | Jul 6 | 213 | +40 |
| GR 01 | " | " | " | Jan 3 | 131 | -33 | Mar 16 | 163 | +18 |
| LW 01 | " | " | " | Apr 19 | 177 | +36 | Jul 18 | 219 | +39 |
| LW 03 | Mar 29 | +22.1 | 187 | Jan 21 | 158 | -37 | Jul 26 | 245 | +40 |
| MO 03 | " | " | " | Feb 13 | 168 | -30 | Jun 7 | 220 | +40 |
| AN 03 | " | " | " | ? | - | - | ? | - | - |

## III. NOTES AND MAPS FROM THE OBSERVATIONS OF 1877--1907

### Notes on the Individual Sources

#### 8.01--8.04. Dreyer, Green, Lohse, Niesten 1877 (Ref. 20)

The 1877 observations of Dreyer, Green, Lohse, and Niesten included in this report were obtained from the summary article of Bakhuyzen (1897) on the rotation period of Mars. In this article Bakhuyzen selected ten well known points on the surface of Mars for which he could compare 1877 coordinates from the observations of Schiaparelli and the four above. Since Bakhuyzen's point 10 was measured only by Schiaparelli, it is omitted, leaving 9 points measured by the four other observers. The following table shows which points were measured by each of them, and what values of $\lambda$ were obtained, with the number of longitude observations, $N_\lambda$, for each:

| KML No. | BK 77 | DR 77 | GN 77 | LH 77 | NI 77 |
|---|---|---|---|---|---|
| 1 | 1 | $5^\circ.9$ (1) | $0^\circ.3$ (2) | | |
| 18 | 2 | | 8.9 (2) | | |
| 83 | 3 | 91.9 (2) | 85.7 (3) | $93^\circ.4$ (7) | $886^\circ.9$ (4) |
| 127 | 4 | | 108.8 (2) | | |
| 177 | 5 | | 169.4 (2) | 167.1 (4) | 181.9 (3) |
| 219 | 6 | | 220.8 (2) | | |
| 246 | 7 | 250.6 (2) | 245.0 (2) | | |
| 263 | 8 | 245.5 (1) | 250.9 (3) | 247.5 (3) | |
| 290 | 9 | 288.7 (2) | 285.8 (3) | 292.5 (4) | 292.9 (2) |

#### 8.05. Schiaparelli 1877 (Refs. 6, 36)

Of the 62 points whose coordinates were measured by Schiaparelli in 1877 and published in his Memoria I (Ref. 4, pp. 34-41, and 43-44), 54 were included with his 1879 measurements in the "General Catalogue of Areographic Positions, Observed in 1877 and 1879 and Reduced to One System." The reason for this repetition was simple: It enabled him to present correct positions for these points, after removing

erroneous light-time corrections from his 1877 coordinates in Memoria I. The source of the error is explained in a footnote to his acknowledgment of Marth's ephemeris (M.N. 39, 468) on p. 249 of Memoria II (Ref. 6).

## 8.06. Winnecke 1877 (Ref. 10)

Winnecke's two observations are identified by Wislicenus (p. 66) as transits of Schiaparelli's point 51 ("Gran Sirte e bocca del Nilo"), hence, presumably of the north tip of Syrtis Major, depending on what Winnecke saw there. The two transit times were:

| | a | b |
|---|---|---|
| 1877 September 10 | $11^h26.^m0$ | $11^h48.^m5$ |
| 1877 September 11 | $12^h1.^m0$ | $12^h23.^m5$ |

a Strassburg Time (his column II)

b Berlin Mean Time (his column III)

## 8.07. Burton 1879 (Ref. 5)

Latitudes in general: Burton's signs are contrary to the usual conventions since his north latitudes are negative, and south positive.

His designation of east and west is also different but not so consistent, requiring preliminary correction of the following points:

| | |
|---|---|
| 11, 16, 29 | for west, read east |
| 22, 23, 30 | for east, read west |

The errata, in which the longitude of point 7 is corrected to read $93^\circ$, include a handwritten note by Burton (in our reprint):

> "The longitudes of the Central Meridian of Sketches 12, 14, 15 should be increased by $16^\circ$. Consequently the longitudes of Trouvelot Bay [point 12: Titanum Sinus] and of Huggins Bay [point 17: Cyclopum Sinus] should be, respectively, $175^\circ$ and $243^\circ$. The Numbers opposite to these names in the Table of Differences [p. 167] must therefore be increased by $-6^\circ$ and $-2^\circ$, respectively."

North and south are everywhere used in their correct areographic senses, but see note to point 28; we assume that by "Banks Cape (north end)" he means the north outlet of an isthmus connecting the actual cape so named by Green [Hammonis Cornu] with Hirst Island [Japygia], as he notes on p. 162:

> "Banks Cape appears prolonged into an isthmus, dividing the Kaiser Sea [Syrtis Major] from Herschel II Strait [Sabaeus Sinus]. Possibly this isthmus is simply formed by a union of Hirst Island with Banks Cape, a state of things which seems to have been the rule in 1862 and 1864, according to the evidence of Professor Kaiser."

Also, on p. 166, line 6, the point is described as "Banks Cape; junction with Beer Continent [Aeria]."

## 8.08. Lohse 1879 (Ref. 7)

The clear presentation of his 1879 data, including a map on p. 73 and a list of coordinates on p. 74, leaves nothing to be desired. A transit of Solis Lacus center (KML 83), not listed by Ashbrook in Ref. 3, is given on p. 65: 1879 October 15: $12^h12^m$ Berlin Mean Time, from which Lohse derives $\lambda = 91^\circ.0$ in Marth's ephemeris.

## 8.09. Niesten 1879 (Ref. 12)

These notes refer to the list on pp. 27-30, unless otherwise noted. Throughout, Neisten reverses the areographic senses of east and west (cf. p. 6), which are corrected below only when otherwise discussed; also, Margaritifer Sinus is misspelled almost everywhere.

| Point | Remarks |
|---|---|
| 1. | Correcting the Dec. 6 $\varphi$ to $-8^\circ$, as on p.23 (probably misidentification of Portus Sigeus?), and deleting the second Nov. 29 measure (not significant) and the Jan. 3 and 12 measures, we have: $\lambda = 0^\circ$, $\varphi = -6^\circ$. |
| 2. | Correct $\varphi$ to $+30^\circ$, as on p. 23 and implied by NPD = $60^\circ$ on p. 31; Niesten copies the NPD as $\varphi$ by mistake. |
| 3. | Nov. 29 measure kept, though not listed on p. 23; adding |

measures from point 56, which is identical, we have: $\lambda = 358^{\circ}$, $\varphi = -31^{\circ}$. Argyre extends further east than seen by Schiaparelli; may be a cloud formation, or fading of band from Schiaparelli's point 8b; cf. point 20.

4. Deleting Jan. 12 measure, we have: $\lambda = 28^{\circ}$, $\varphi = -20^{\circ}$.

5. Niesten confuses Indus with Nilus near edge of drawing 3; thus the point is the intersection of Oxus and Indus (equals Schiaparelli's 5a), and not equal to point 2, as former name would imply (perhaps mere misprint on pp. 27 and 31, since he writes Indus and Nilus on p. 9); also correct drawing time to $12^{h}0^{m}$.

6. Correct name to Deucalionis Regio, west point; deleting Jan. 3 measure (drawing 1, not 4 as printed), we have: $\lambda = 22^{\circ}$, $\varphi = -20^{\circ}$.

7. Correct name to Tip of Margaritifer Sinus; reverse drawing numbers (3) and (40) in last column of table; correct second Nov. 29 $\varphi$ to $+5^{\circ}$ as on p. 9, drawing 3; deleting measures for Oct. 16 ($60^{\circ}$ from central meridian) and Jan. 3, we have: $\lambda = 23^{\circ}$, $\varphi = -5^{\circ}$.

8. Read Jamuna; add drawing time $12^{h}0^{m}$; correct $\varphi$ to $+40^{\circ}$, as on p. 9 and implied by NPD = $50^{\circ}$ on p. 31. Averaged with point 9, new coordinates are: $\lambda = 25^{\circ}$, $\varphi = 34^{\circ}$.

(9) Happens to be same point as 8, since Niesten draws Indus and Jamuna issuing from Nilus at the same mouth; correct $\varphi$ to $= 28^{\circ}$, as on p. 23 and implied by NPD = $62^{\circ}$ on p. 31.

11. Nov. 29 measure belongs to point 12, according to p. 9; drawing 3, however, clearly has Aromatum Promontorium at the given coordinates so the measure is kept; deleting measures for Jan. 3, we have: $\lambda = 37^{\circ}$, $\varphi = -11^{\circ}$.

(12) Discarding Dec. 6 measures of intersection of Pyrrhae Regio with limb, we have $\lambda = 32^{\circ}$, $\varphi = -10^{\circ}$, which are assigned to point 11 on the basis of drawing 3.

13. Omit first measurement of each pair on drawings 3 and 4, changing means to $\lambda = 58^{\circ}$, $\varphi = -10^{\circ}$; the omitted measurements belong to and are given under point 17 by him.

15. West point of Argyre II; Niesten would write Point Est to match point 10.

16. Averaged with first measure of point 19, new coordinates are: $\lambda = 64^{\circ}$, $\varphi = 28^{\circ}$.

18. Correct $\varphi$ to $-40^{\circ}$, as on p. 10 and implied by NPD = $130^{\circ}$ on p. 31; cf. point 23.

19. Transferring first measure to point 16, new coordinates are: $\lambda = 89^{\circ}$, $\varphi = 35^{\circ}$ (poor measure).

20. Nov. 29 measures discarded, since not of Argyre, but of points where it merges with west limb brightening; the remaining measure, $\lambda = 76^{\circ}$, $\varphi = -45^{\circ}$, is the west point of a confusion of Argyre and Ogygis Regio on a very poor drawing.

21. Better identified with Schiaparelli 12a.

23. Unusual extension of Ogygis Regio.

28. Poor measures; perhaps Schiaparelli 16a?

29. Measured on very poor drawing; point unidentifiable.

30. Point defined only in latitude; longitude is arbitrarily chosen.

34. Better identified with Schiaparelli 30a.

35. Poor latitude--about $15^{\circ}$ too far north, as are many of the following points.

36. Correct drawing number to (26).

37., 37a., 38., 38a. Misidentification; not Chersonesus, but Thyle II; each point represents an east and a west component, the latter of which is renumbered a.

40. Add drawing number (30).

41. Hesperia apparently misplaced on drawings, but $\lambda$ comes out approximately right.

43. Misidentified for south point of Libya, for which $\varphi$ is still too far north, from poor drawing; including coordinates from drawings 30, 34, and 35 on pp. 20-21, we get for mean coordinates; $\lambda = 282^{\circ}$, $\varphi = +4^{\circ}$.

44. As with point 20, a measure of intersection of Japygia with east limb of drawing 40 was discarded; also discarding the illusory measure on drawing 31, the remaining coordinates of point 44 are: $\lambda = 301^{\circ}$, $\varphi = -10^{\circ}$.

46. Syrtis very near limb on drawings 26 and 27, but the observations are kept nonetheless since all coordinates happen to closely coincide.

47. Correct $\varphi$ to $35^{\circ}$, as implied by NPD = $55^{\circ}$ on p. 31; the NPD was copied as $\varphi$ by mistake.

48. Correct drawing 33 coordinates to $\lambda = 294^{\circ}$, $\varphi = -11^{\circ}$, as on p. 20, and add the second list of points under point 57, discarding the illusory measure from drawing 31, on which the region of Ausonia is badly distorted; the new coordinates of Ausonia (or Trinacria), east point, are $\lambda = 293^{\circ}$, $\varphi = -9^{\circ}$.

49. Center of Hellas--not Schiaparelli 53 (Niesten copies Schiaparelli's map misprint, showing that he worked from the map rather than the tables); deleting the Jan. 11 observations, we have: $\lambda = 304^{\circ}$, $\varphi = -35^{\circ}$ (kept, though not on p. 21).

49a. North point of Hellas; deleting Jan. 12 measure, we have: $\lambda = 305^{\circ}$, $\varphi = -25^{\circ}$.

49b. East point of Hellas; discarding measures on Dec. 2 of Hellas-limb intersection, on Nov. 5 of approximate east point of Ausonia Australis, which is fused with Hellas, and on Dec. 9 of northeast edge of Hellas, we have: $\lambda = 276^{\circ}$, $\varphi = -50^{\circ}$.

49c. West point of Hellas; deleting measures from drawings 29 (on which Hellas merges with west limb) and 32 (on which Hellas merges with Noachis), and correcting drawing 34's $\varphi$ to $-38^{\circ}$, as on p. 21, we have: $\lambda = 335^{\circ}$, $\varphi = -38^{\circ}$ (Hellas is abnormally enlarged on drawing 35, which also affects point 49.)

51. Dec. 6 measure discarded, due to distortion on drawing 33; new means: $\lambda = 312^{\circ}$, $\varphi = -10^{\circ}$.

52. Discarding Jan. 11 and 12 measures, we have: $\lambda = 328^{\circ}$, $\varphi = -10^{\circ}$.

(53) Discarding Jan. 11 and 12 measures, we eliminate the point.

54. Change name to Mouth of Orontes (Schiaparelli 62); discarding Jan. 11 measure, we have: $\lambda = 342^{\circ}$, $\varphi = -10^{\circ}$.

55. Discarding Jan. 11 measure (drawing 37, not 28), and adding Oct. 27 from p. 22, drawing 36, we have: $\lambda = 340^{\circ}$, $\varphi = -16^{\circ}$.

56. From drawings 34 and 35, correct name to Argyre, east point -- averaged with point 3.

57. East point of Ausonia Borealis (Trinacria); discarding measures on drawings 32--35 (on which Ausonia intersects the east limb) and 28 (on which an indistinct point on Ausonia's south edge was measured), we have: $\lambda = 244^{\circ}$, $\varphi = -34^{\circ}$.

58. Niesten's "Rosse Land (Côte Australe)" is the south edge of the north polar cap.

(59) "Mare Chronium" is outlined on the north by these three arbitrary points.

(60) "Mare Cimmerium" is outlined on the north by these three arbitrary points.

Points whose numbers appear in parentheses have been omitted from the maps and master list of this report.

Corrections to the plate of 40 drawings include:

| No. | Remarks |
|---|---|
| 1. | Diameter 12".0; 5 measures made on it discarded as worthless. |
| 2. | L ($\omega$) = $55^{\circ}$ in plate for $56^{\circ}$ in text; here and subsequently the text value is taken as correct on the basis of the errors in drawings 16 and 30, which are unmistakable from the features. |
| 3. | L = $67^{\circ}$ in plates for $64^{\circ}$ in text; also correct date to 29 Nov. |

4. L = 68° in plates for 67° in text.
7. L = 77° in plates for 75° in text.
9. L = 88° in plates for 71° in text.
11. L = 131° in plates for 130° in text.
15. L = 150° in plates for 155° in text.
16. L = 160° in plates obvious error for 168° in text, p. 15, where drawing is correctly placed between 19 and 20 by longitude.
17. L = 164° in plates for 158° in text.
18. L = 165° in plates for 164° in text.
30. L = 280° in plates obvious error for 289° in text, p. 20, where drawing is correctly placed between 32 and 33 by longitude.

## 8.10. Schiaparelli 1879 (Refs. 6, 36)

On p. 286, Schiaparelli gives the arbitrary zero-point longitude corrections necessary to remove the mean systematic differences between 1877* (absolute), 1879* (absolute), and 1879 ⊕ (relative) by altering the 1879 coordinates to be consistent with the 1877, as follows:

$$\lambda_{77*} - \lambda_{79*} = + 1^{\circ}.64 \pm 0^{\circ}.33$$

$$\lambda_{77*} - \lambda_{79\oplus} = + 2^{\circ}.49 + 0^{\circ}.44$$

We have undone these by simply applying - 2°.0 to each mean 1879 λ in the 1879 list.

On p. 287, Schiaparelli explains a correction applied to his 1877 latitudes on the basis of his 1879 re-determination of the position of Mars' pole of rotation. This latitude correction is:

$$\varphi_{79} - \varphi'_{77} = + 2^{\circ}.97$$

Here $\varphi'_{77}$ reduces $\varphi_{77}$ to the usual areographic sense, since Schiaparelli took $\varphi_{77}$ with south positive; thus, $\varphi'_{77} = -\varphi_{77}$. We follow Schiaparelli in applying this correction (rounded off to + 3°.00 "for greater facility") to the 1877 latitudes, to bring them into the 1879 system.

## 8.11. Niesten 1881 (Ref. 13)

| Point | Remarks |
|---|---|
| 1. | Delete drawings 1, 18, and 19. |
| 2. | Margaritifer Sinus not seen on drawing 1, whose measure is deleted. |
| (3) | Features lost in terminator shading on drawing 1 (deleted). |
| 9. | Solis Lacus not recognizable on drawing 4 (deleted). |
| 10. | Bright spot in Tractus Albus (drawing 1; deleted). |
| 11. | Assumed to be Titanum Sinus; "Trouvelot Bay" ambiguous. |
| 12. | Elysium more oval and northerly than usual; add drawing number (9). |
| 13. | Not usual west tip, due to cloud on drawing 9; drawing 12 discarded. |
| 14. | Due to cloud on drawing 9, measure discarded, drawings 11 and 12 already deleted, leaving $\lambda = 268^{\circ}$, $\varphi = -9^{\circ}$. |
| 15. | Add drawing number (14). |
| 16. | Center of Moeris Lacus (quite large). |
| (17) | Point too close to limb to be identified on drawing 9 or 1, so discarded. |
| 18. | Bright spot next to Nilosyrtis; delete drawing 11. |
| 19. | Apparently center of Syrtis Major; delete drawings 11, 12, 18, and 19. |
| 20. | East point of unusual extension of Sinus Sabaeus; need $\lambda = 300^{\circ}$ in drawing 14 measure. |
| 21. | Correct mean coordinates to $\lambda = 312^{\circ}$, $\varphi = 023^{\circ}$; delete drawings 18 and 19. |
| (22) | Sinus Sabaeus badly distorted; delete drawing 1 and point. |
| (23) | Mid-point of canal useless; delete drawing 1 and point. |
| (24) | Mare Hadriaticum distorted and near limb; delete drawing 1 and point. |
| (25) | Too near limb in drawing 9; add number and discard drawing and point. |

In the above list, it may be seen that all measurements made on drawings 1, 4, 11, 12, 18 and 19 have been discarded, as well as all points measured only on those drawings. The poor quality of the

drawings discarded is easily explained if it is noted that along with drawings 3, 7 and 10, on which no points were measured, all these drawings were made when the apparent angular diameter of Mars was less than 11 seconds of arc.

## 8.12. Denning 1884 (Ref. 23)

Denning measured four times of central meridian transits of Syrtis Major (KML 295) in 1884: February 14, $5^h55^m$; February 15, $6^h35^m$; February 19, $9^h5^m$; February 22, $11^h4^m$. The times, although not so stated, must have been Greenwich Mean Astronomical Time.

## 8.13. Knobel 1884 (Refs. 8, 9, 15)

Transit Observations

| KML | Pt. | Station | Date, Time | Reference | Notes |
|---|---|---|---|---|---|
| 083 | 001 | Solis Lacus | 6 Feb., $11^h45^m$ GMAT | (8) p. 278, (15) p. 380 | a, b |
| 288 | 002 | Syrtis Major | 17 Feb., $7^h50^m$ GMAT | (8) p. 280, (9) p. 205, (15) p. 378 | b, c |

a) $\lambda = 83.^\circ0$, computed by Knobel from Marth's ephemeris.

b) The two 1884 observations (Ref. 8) are taken from Ref. 3 with correction of point 002 to point 288.

c) The erroneous labeling of point 002 as Sinus Meridiani in Refs. 3, 9, and 15 must derive from a misunderstanding of the abbreviation S.M., which actually stood for Syrtis Major.

## 8.14. Lohse 1884 (Ref. 16)

The chief results of Lohse's 1884 positional measures on Mars drawings are given in a table on p. 140. For two other points, one of which was point 14 of the table and the other one new (point 19), only transit times are given on pp. 133 and 138 (not pp. 128 and 137, respectively, as in Ref. 3).

## 8.15. Lohse 1886 (Ref. 16)

Three transits measures of the center of Syrtis Major are given on p. 138.

## 8.16. Schiaparelli 1886 (Refs. 24, 36)

On p. 274 (Ref. 36), Schiaparelli gives the following longitudes, derived from unstated transit times, presumably using Marth's ephemeris:

| KML | Pt. | Name | $\lambda$ | Date |
|---|---|---|---|---|
| K362 | 001 | Fastigium Aryn | $361^{\circ}.13$ | 6 April 1886 |
| K352 | 002 | Ismenius Lacus | 336.40 | 7 April 1886 |

Taking $\lambda$ (001) equal to $0^{\circ}.00$, he also gives $\lambda$ (002) = $335^{\circ}.27$.

## 8.17. Lohse 1888 (Ref. 16)

One transit of Syrtis Major is given on p. 138. Time is given as $9^{h}20^{m}.0$ on line 5, but $9^{h}21^{m}.0$ in Table; recomputation shows $9^{h}21^{m}$ to be the time corresponding to $\lambda$ (Marth) = $292^{\circ}.38$.

## 8.18. Schiaparelli 1888 (Refs. 24, 36)

On p. 274 (Ref. 36), Schiaparelli gives the following individual longitudes, derived from unstated transit times, presumably using Marth's ephemeris. We have taken means and corrected two errors, one rather strange.

| KML | Pt. | Name | $\lambda$ | Date (1888) | $\bar{\lambda}$ |
|---|---|---|---|---|---|
| 362 | 001 | Fastigium Aryn | $359^{\circ}.75$ | 31 May | $360^{\circ}.17$ |
| | | | 360.60 | 2 June | |
| 352 | 002 | Ismenius Lacus | 342.73 | 30 May | $342^{\circ}.08$ |
| | | | 341.28 | 31 May | |
| | | | 342.22 | 1 June | |

Although $\lambda$ (001) = $360^{\circ}.17 = 0^{\circ}.17$, Schiaparelli must have erroneously obtained a value of $0^{\circ}.22$ since he subtracted this amount from the individual $\lambda$ (002) coordinates to reduce them to $\lambda$ (001) = $0^{\circ}.00$. Thus his mean $\lambda$ (002) = $341^{\circ}.86$ (misprinted as $341^{\circ}.53$ in line 3 of footnote) should be $341^{\circ}.90$ relative to Fastigium Aryn.

## 8.19. Wislicenus 1888 (Refs. 11, 15)

The identification of the points measured needs no comment or correction.

## 8.20. Wislicenus 1890 (Refs. 14, 15)

The identification of the points measured needs no comment or correction.

## 9.01. Lohse 1892 (Ref. 19)

On p. 5, lines 9-11, Lohse gives the transit time (1892, August 11, $10^h6^m.6$ GMAT) and derived longitude ($\lambda = 4^\circ.4$) of the "Gabelbai," Sinus Meridiani. The ephemeris used was probably that of Marth, and the point measured was probably the center of the bay, also measured by A. S. Williams that year, rather than the tip of Fastigium Aryn, but the exact identification is doubtful.

## 9.02. Pickering 1892 (Ref. 38)

This isolated longitude is quoted by Maggini, p. 238, in connection with other measures of the tip of Margaritifer Sinus in order to demonstrate a shift in longitude of this point. However, nothing except the resultant $\lambda = 17^\circ.2$ is known of the observation, so the measure is of correspondingly little value.

## 9.03. Williams 1892 (Ref. 18)

Williams' transits are neatly collected in his Table V on p. 192 of the 1892 BAA Report. The point locations are precise, and the transit times have been conveniently converted to longitudes by means of "the times of transit of the zero meridan given by Mr. Marth in his Ephemeris" (p. 193, lines 5-6). For the following five points observed twice each, only the individual observed longitudes were given, so we have adopted the following mean values:

| Pt. | $\lambda^*$ |
|---|---|
| 001 | $10^\circ.9$ |
| 003 | 46.2 |
| 004 | 51.4 |
| 005 | 63.4 |
| 008 | 300.2 |

*$N\lambda = 2$

## 9.04. Lowell 1894 (Refs. 17, 22)

| Point | Remarks |
|---|---|
| 7. | "Aurorae Sinus (centre)" implies middle of dark bay, but the coordinates place it on the north shore, either at the east mouth or between the two mouths of the Ganges. |
| 9. | "Lacus Lunae" is our Lunae Lacus, but not Lowell's, having the coordinates of his Labeatis Lacus; his Lunae Lacus is further up Ganges, at $\varphi = +12^\circ$. |
| 12. | Add $121^\circ.5$ to $\lambda$-corrected column in Ap. J. list. |
| 20. | "Scamander" implies either the middle or mouth of the canal; here the point is on the north edge of Electris, $10^\circ$ east of mouth of Scamander. |
| 22. | "Mare Cimmerium (mouth of the Palinurus)" agrees with the mouth either of Scamander or of Avernus and Laestrigon since no $\varphi$ is given; probably the latter. |
| 23. | "Mare Cimmerium (mouth of the Avernus)" should agree with point 22, but is $6^\circ$ west of it. |
| 25. | "Eridania (centre)" shares in the problem of point 20; the move of $7^\circ$ west and $10^\circ$ south, which would move point 20 to the middle of Scamander would move point 25 to the middle of Eridania, on whose northeast shore it now is. |
| 28. | Read Libya for Lybia in Ap. J. list. |
| 29. | Lowell shares Niesten's misapplication of Circaum Promontoriun to Libya in Ap. J. list. |
| 31. | "Hellas (centre of northern end)" implies middle of north shore, but coordinates are $3^\circ$ or $4^\circ$ too far south, yet not far enough to be middle of north half of Hellas. |

33.
34.
35. } Reverse Euphrates and Phison in Ap. J. list. On Plate XIX map - reverse nos. 32 and 34.

Some points have slightly different longitudes in the two lists, of which the Annals list is taken as authoritative, having been published later; the only difference $\Delta\lambda$ (Ap. J.--Annals) greater than a degree is $+2^{\circ}.0$ for points 33--35; other $\Delta\lambda$'s are: $+0^{\circ}.2$ (point 31), $+0^{\circ}.1$ (points 12 and 32), $-0^{\circ}.1$ (point 10), $-0^{\circ}.3$ (point 36), and $-1^{\circ}.0$ (points 16, 17 and 18).

## 9.05. Cerulli 1896 (Ref. 21)

List

Point 57 -- value of $\varphi$ listed is actually $\Delta\lambda$ measured as given on p. 29; there is no $\varphi$, since the point is "defined only in longitude."

Map

Positions often slightly different from given coordinates; discrepancy worse outside $\lambda = 180^{\circ}$, where features are repeated with even less faithful precision of placement. At $\lambda = 82^{\circ}$, $\varphi = -9^{\circ}$, Trithomius is printed as a typographical error for Tithonius.

The longitudes are relative to mid-point between two horns of Aryn (points 1 and 2) = $0^{\circ}$.

Two new points were added to the list: point 1a, Fastigium Aryn, $\lambda = 0$; point 26a, east point of Mare Tyrrhenum, $\lambda$ same as point 26, Simois (p. 22).

## 9.06. Lowell 1896 (Ref. 26)

These coordinates of oases, based on an unknown number of unspecified measurements, are given in a table on p. 435-436.

## 9.07. Cerulli 1899 (Ref. 25)

| Point | Remarks |
|---|---|
| 1.<br>2. | Cerulli himself discarded a second set of latitude measurements made in February, $\varphi = 9^{\circ}$, since they confirmed his impression that the horns had become thinner and longer. |
| 2a. | Fastigium Aryn south point, $\varphi$ given on p. 166 = $-2^{\circ}.6$. |
| 3. | Thymiamata -- south point. |

5. Southeast corner (of leading edge) of Mare Acidalium measured $\lambda = 18.^{\circ}7$, changed to "scarcely $10^{\circ}$" ($\sim 12^{\circ}$) on map.

9. The single direct measure gave $\lambda = 27.^{\circ}1$; mean of points 4 and 12 gave $\lambda = 27.^{\circ}4$.

10. $\varphi$ only; measured $\varphi = 35.^{\circ}7$ changed to $38^{\circ}$ on map.

13. Southwest corner of Mare Acidalium (west point of top edge).

15. Mouth of Ganges (west component) in Aurorae Sinus.

18. Lacus Tithonius (center).

20. East point of Mare Sirenum (incidentally also mouth of Araxes, et al.; "Gulf of Hercules").

21. Measured $\lambda = 156.^{\circ}3$ changed to about $153^{\circ}$ on map.

22. East point of "Propontis 1."

26. West point of "Propontis 2."

36. West (following) edge of Hellas.

38. East mouth of Euphrates.

40. West mouth of Euphrates.

### 9.08. Denning 1899 (Ref. 23)

The transit time alone is given: 1899 March 7, $8^{h}31^{m}$ GMAT.

### 9.09. Antoniadi 1901 (Refs. 27, 34)

The coordinates are given on pp. 523-524 of Flammarion's Vol. II (Ref. 33).

### 9.10. Graff 1901 (Ref. 35)

Points are well defined by table, p. 26. Point added: K001, no. 015, Meridian Bai from indication on lines 14-15, p. 26, that this point was used as origin of longitudes.

### 9.11. Lowell 1901 (Ref. 30)

| Point | Remarks |
|---|---|
| A. | Fastigium Aryn = K362; transits of May 4, 8, June 9, 10, and July 18, are on p. 614 of Ref. 28. |
| B. | Ascraeus Lacus = K102; $\lambda = 108^{\circ}$ (transit, April 19), $\varphi = +21.^{\circ}1$ (drawing, pp. 121-122). |

C. "Pro-Propontis" = K150; $\lambda$ = 157; April 19 (p. 130).

D. Propontis = K147; $\lambda$ = 175; April 19 (p. 130).

E. "Post-Propontis" = K184; $\lambda$ = 188°; April 19 (p. 130).

## 9.12. Lowell 1903 (Refs. 30, 31)

| Point | Remarks |
|---|---|
| 2. | May possibly be same as point 1, which was seen a month earlier. |
| 4. | Tip of Margaritifer Sinus; Oxia Palus not seen. |
| 5. | Coordinates 10° south of position on 1903 globe, on which it is located near mouth of Gihon II in Mare Acidalium. |
| 8. | Coordinates on globe place Lowell's southwest tip at mouth of Nilokeras, unlike Molesworth's southwest corner southeast of it (his point 11). |
| 18. | Center of spot of which Molesworth 21 is the east edge, despite disparate $\varphi$. |
| 22. | Very nearly identical to Molesworth 27, which is the west edge of this very narrow lake at the west end of Lowell's Ceraunius or Molesworth's Mareotis Lacus. |
| 23. | Coordinates about 10° west of position plotted on globe; called Maeotis Palus by Antoniadi. |
| 25. | Coordinates about 10° west of position plotted on globe; this lake at the intersection of Pyriphlegethon with Gigas not seen by Molesworth. |
| 27--31. | The Propontis area is exceedingly hard to unravel from Lowell's description in 1903. |
| 27. | Coordinates disagree with globe position, which better agrees with the text coordinates from the special table of latitudes on p. 216, given for each presentation. |
| 28. | Additional coordinates given in text agree better with globe. |
| 28a. | Semnon Lucus: text coordinates only, agreeing with globe. |
| 28b. | Lucus Castorius: test coordinates only, agreeing with globe. |
| 30. | Text coordinates agree much better with globe, since $\varphi$ in list appears to be average of measures of points 30 and 30a, as revealed by common $\lambda$ and $\varphi$ at June presentation and alternate appearance from one measure to the next. |

30a. Ortygia: text coordinates only, agreeing with globe; cf. point 30.

31. Text coordinates agree much better with globe.

32. Lowell's Trivium Charontis is a triangular fusion of the real Trivium with the adjacent part of Styx, unlike Molesworth's Trivium Charontis, which is a dark node in the southeast corner of Lowell's.

33. "Sub snow patches" equals Olympia.

34. Same point as 37, as revealed by common April 26 measure.

37. Add April 27 measure from point 34, given $\lambda = 221.^{\circ}52$ and $\varphi = 57^{\circ}$.

40. "White at South" is probably Ausonia (Australis), although $\varphi$ is not given.

41. Coordinates much better match Molesworth's point 47, the west tip of Mare Cimmerium; perhaps Lowell misidentified his transits?

43.}
44.} Read Casius for Cassius.

45. "Molorchi Nemus" equals Molesworth's "Casius Lacus."

47. Southwest corner of Libya.

50. Intersection of Nilosyrtis with northeast edge of Coloe Palus.

56. Center of Noachis; very poorly defined.

## 9.13. Molesworth 1903 (Ref. 32)

| Point | Remarks |
|---|---|
| 14. | Ambiguous whether mouth of Ganges or center of Sinus is meant. |
| 23. | Intersection of the two circular arcs (see Fig. 2) very vaguely determined. |
| 29. | Name misplaced on map; feature renamed Artynia Fons by Antoniadi. |
| 30. | Name misplaced on map; feature renamed Tatta Lacus by Antoniadi. |
| 38. | Name not used on map; feature renamed Aphnitis Fons by Antoniadi. |

49. Feature nameless on map.

62. Name on map cannot be deciphered.

65. Name changed to Anubidis Fons on Antoniadi's map.

70. Name not used on Antoniadi's map; feature renamed Callirrhoes Fons.

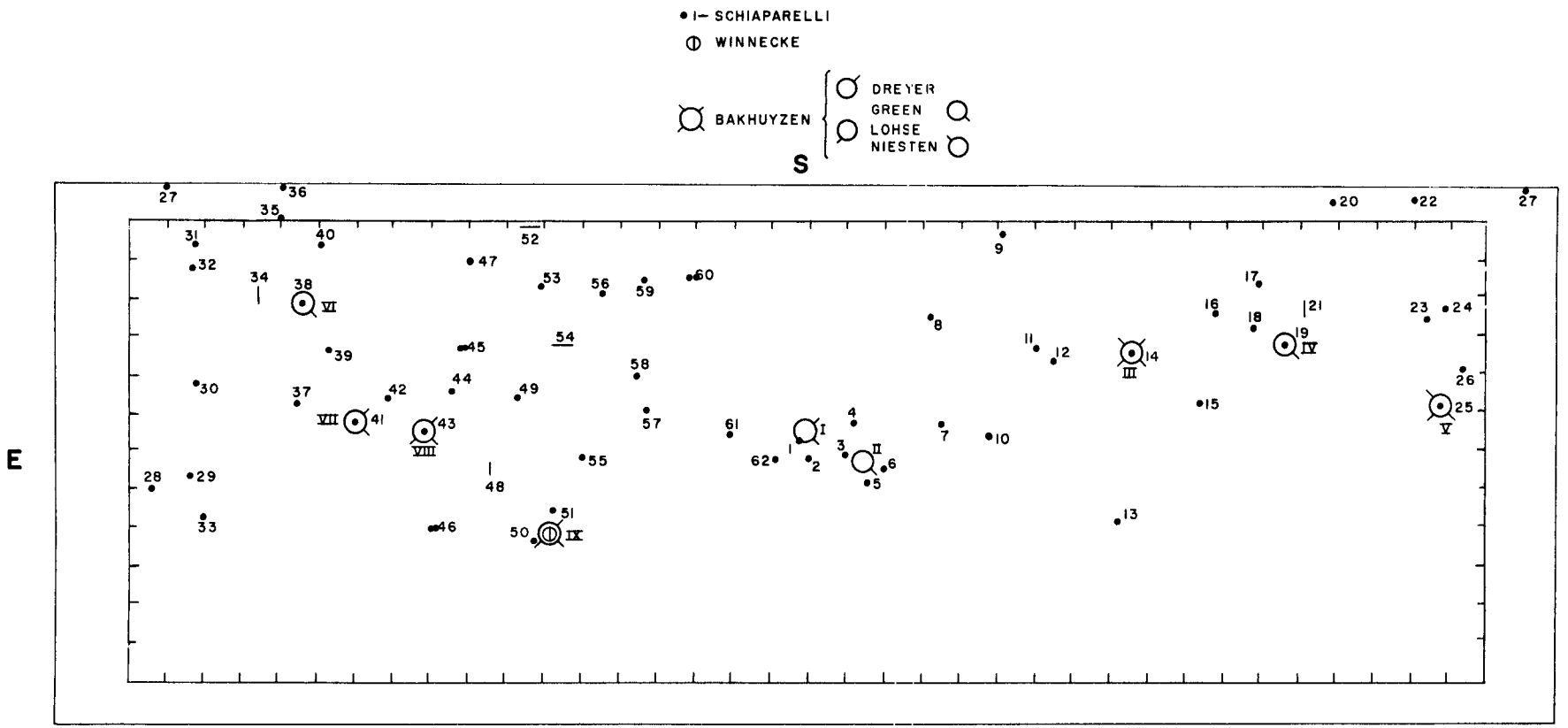
The closest thing to a base map for Molesworth's observations is the 1903 map of the BAA Mars Section, drawn up largely from Molesworth's drawing and even preserving his characteristic style by E. M. Antoniadi, who however altered Molesworth's positions to fit his own and those of past BAA maps.

### 9.14. Antoniadi 1903 (Ref. 29)

The points are given on pp. 63-64 of La Planète Mars (Ref. 37) without details of method or number of measurements.

### Maps from the Individual Sources

The several maps are presented on the following pages in chronological order. These maps are then combined in Section IV. The points noted by individual observers may be approximately located by placing the transparent loose-leaf outline map over any of the maps in this section.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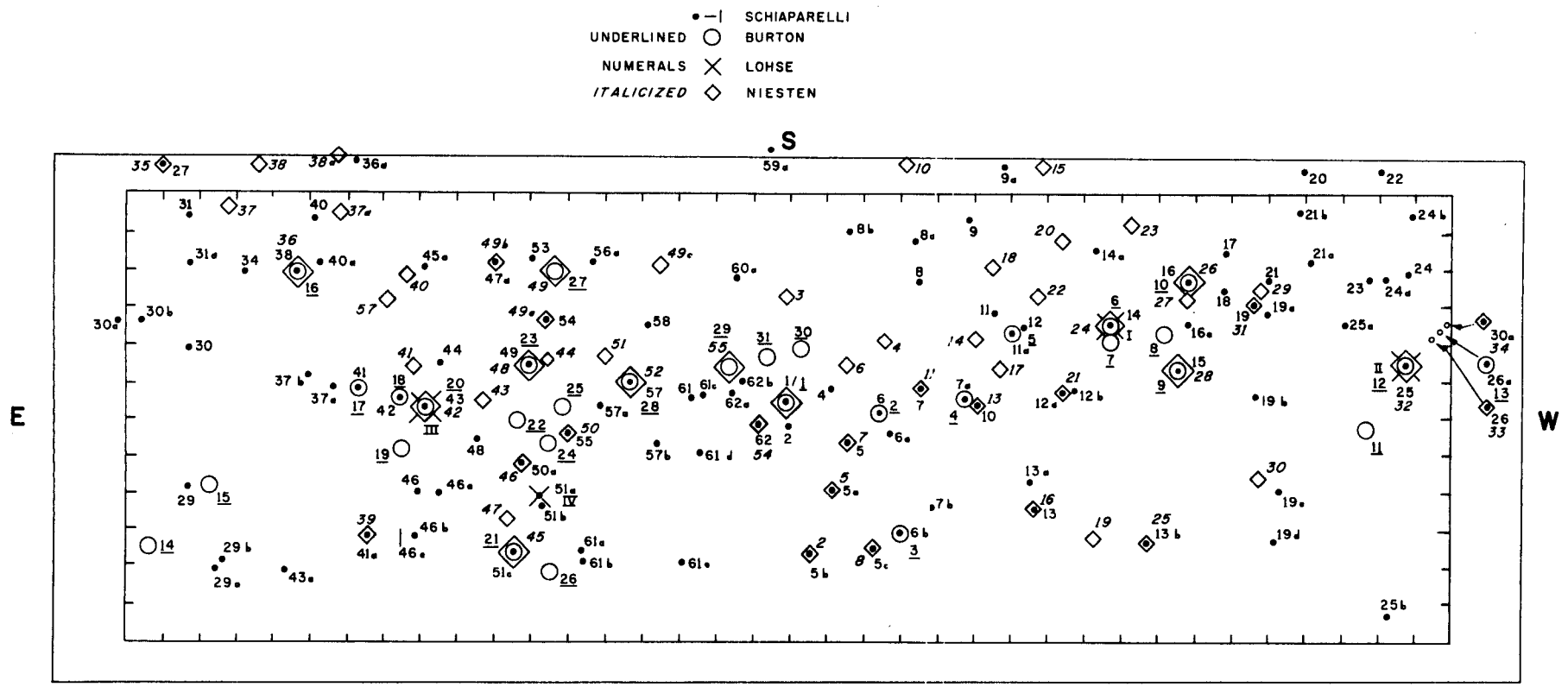
BAKHUYZEN
DREYER
GREEN
LOHSE
NIESTEN
S
E
W
1877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UNDERLINED BURTON
NUMERALS LOHSE
ITALICIZED NIESTEN
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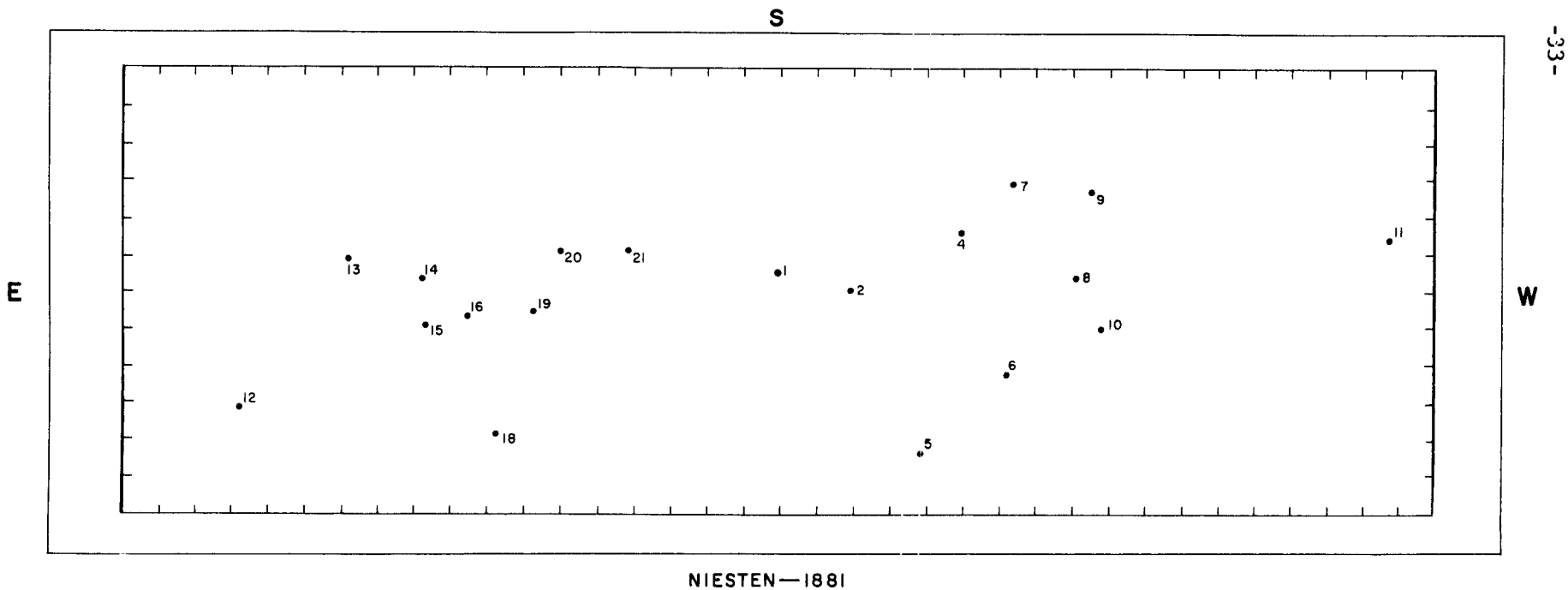
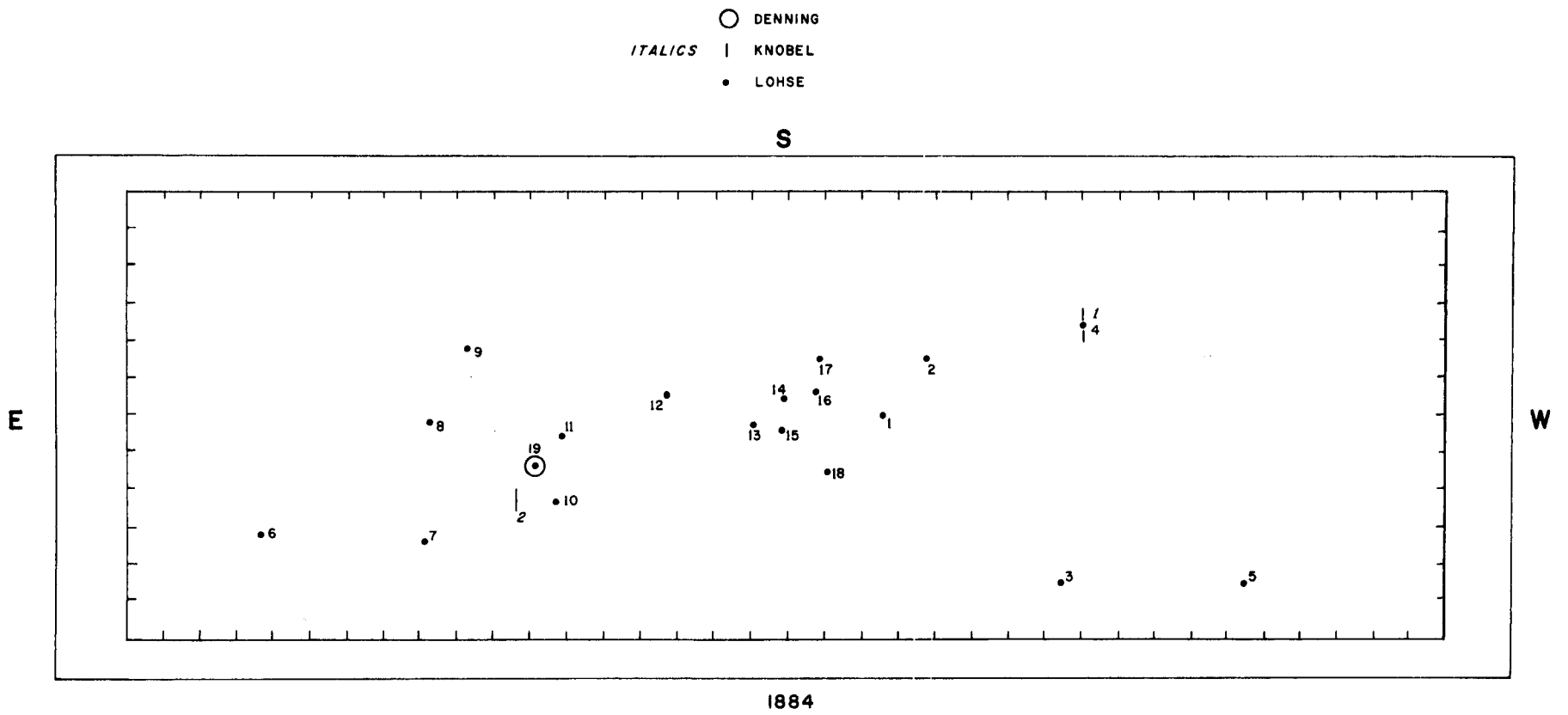
1879




NIESTEN—1881


DENNING
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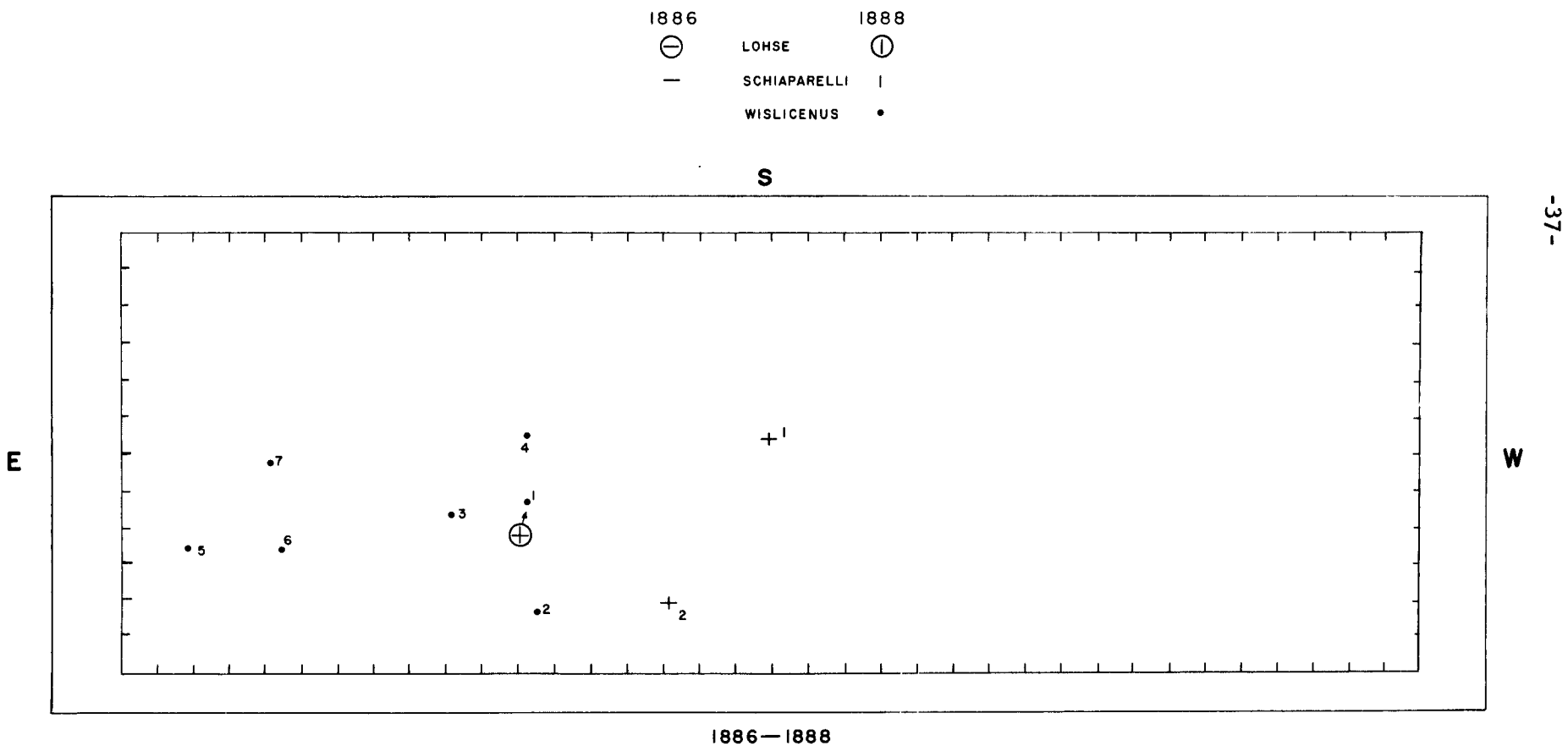
1886
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LOHSE
SCHIAPARELLI
WISLICENUS
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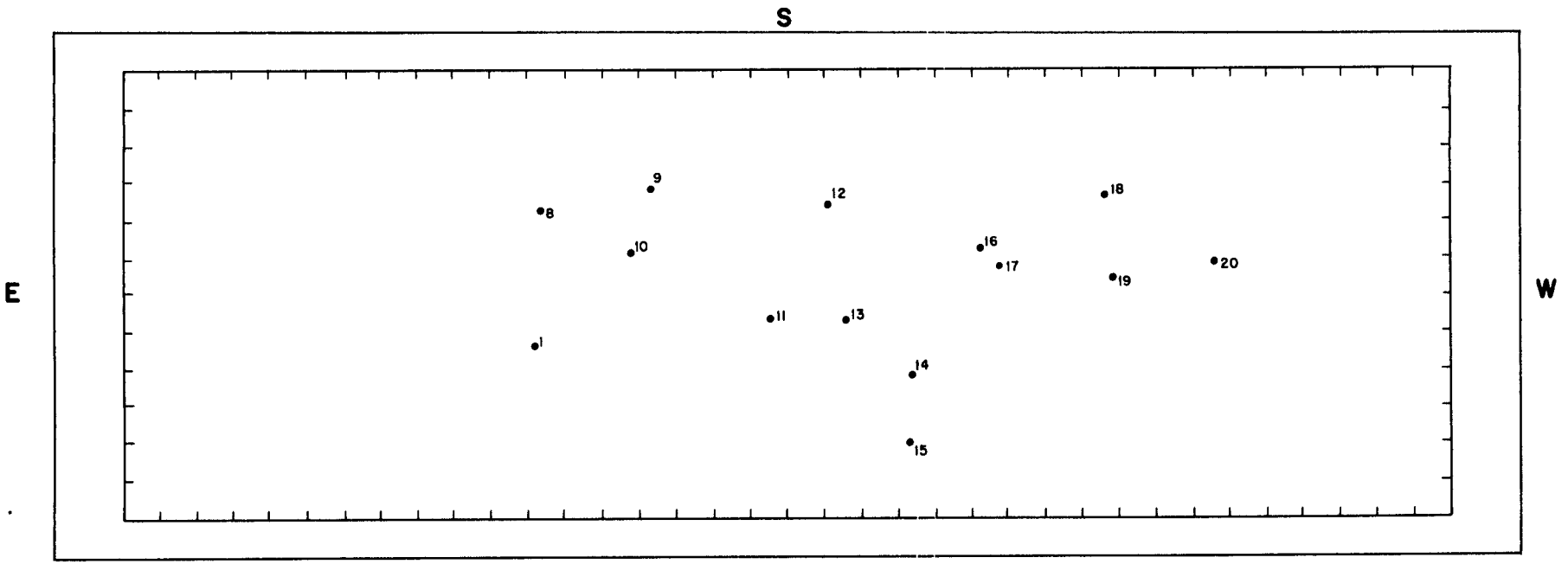
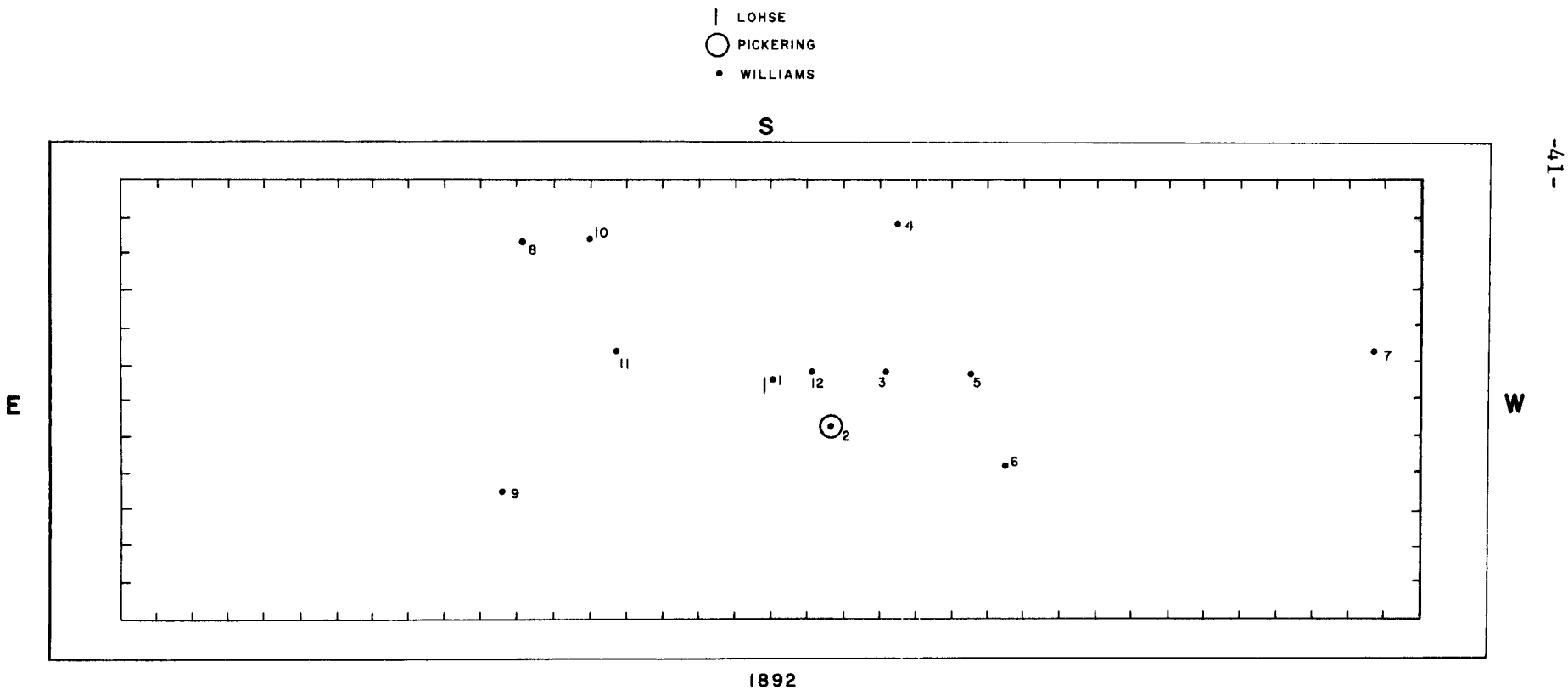
1886—1888




WISLICENUS – 1890


LOHSE
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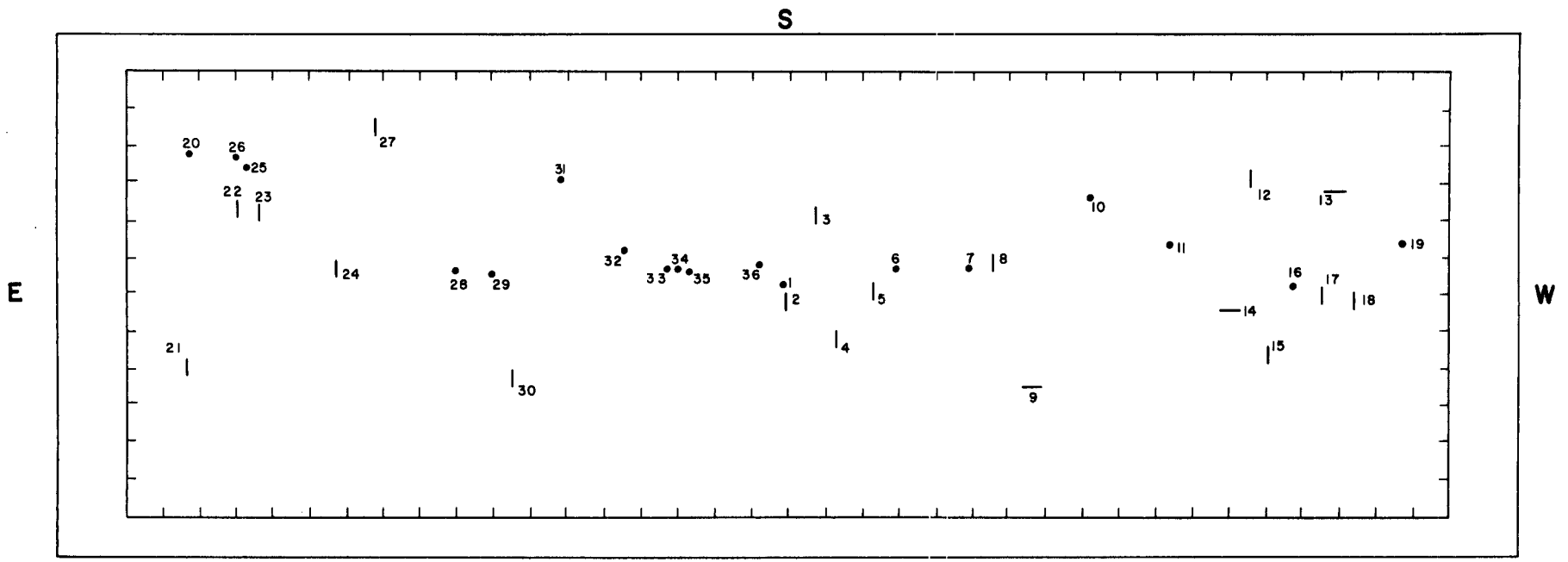
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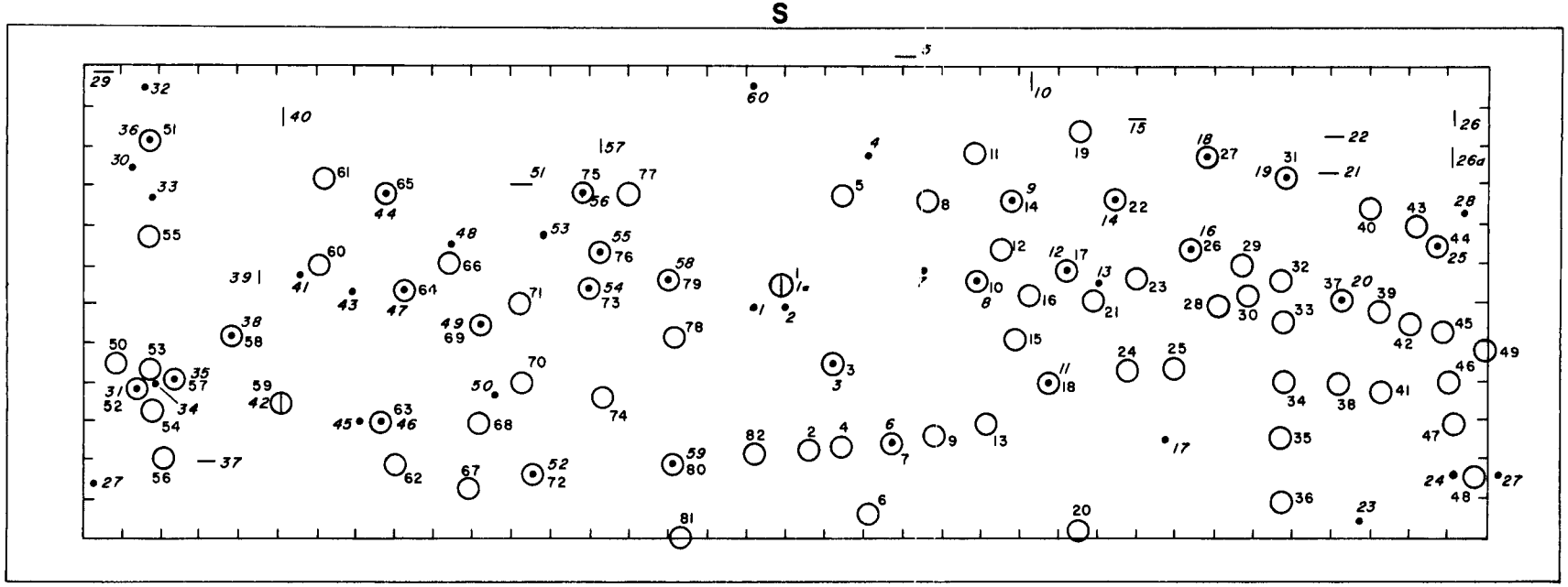
LOWELL – 1894

*ITALICS* • | — CERULLI
○ LOWELL

S

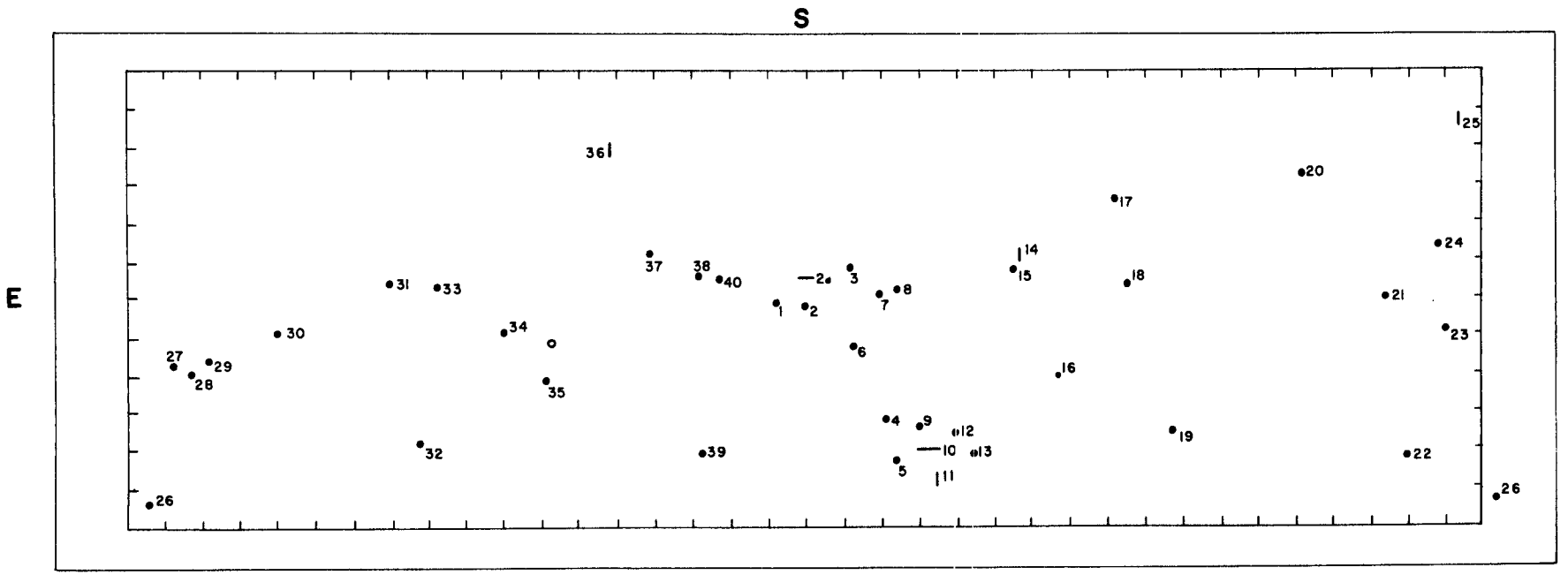


W

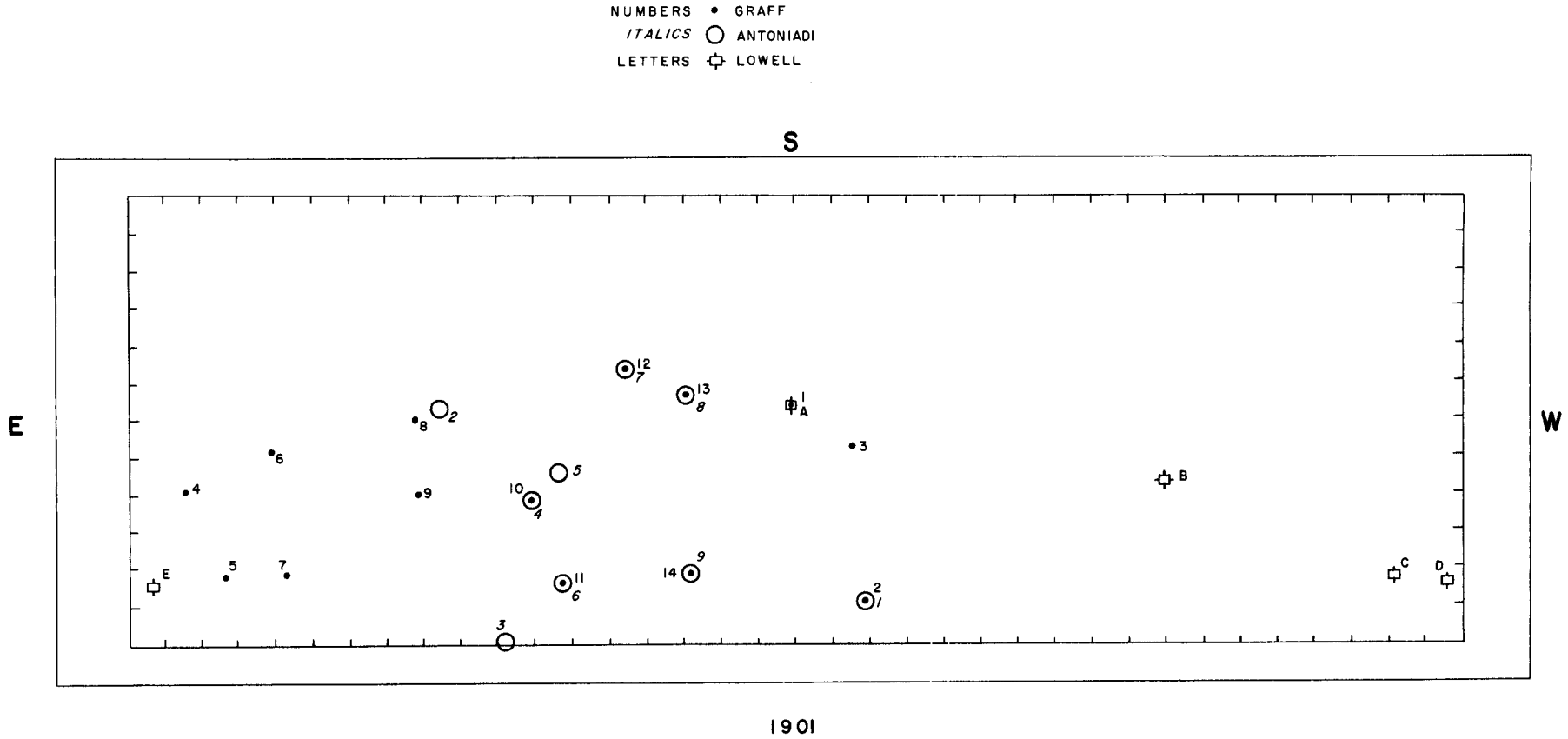
1896

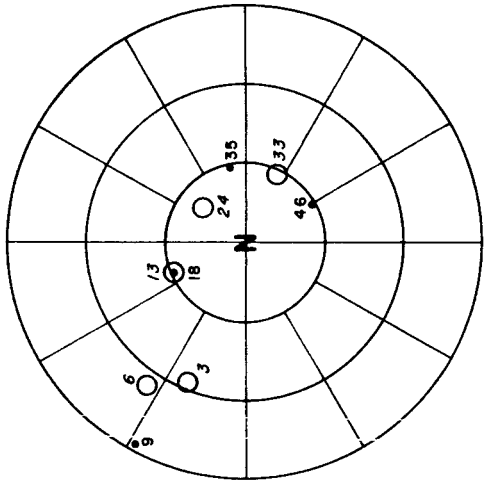
• 1 — CERULLI

o DENNING



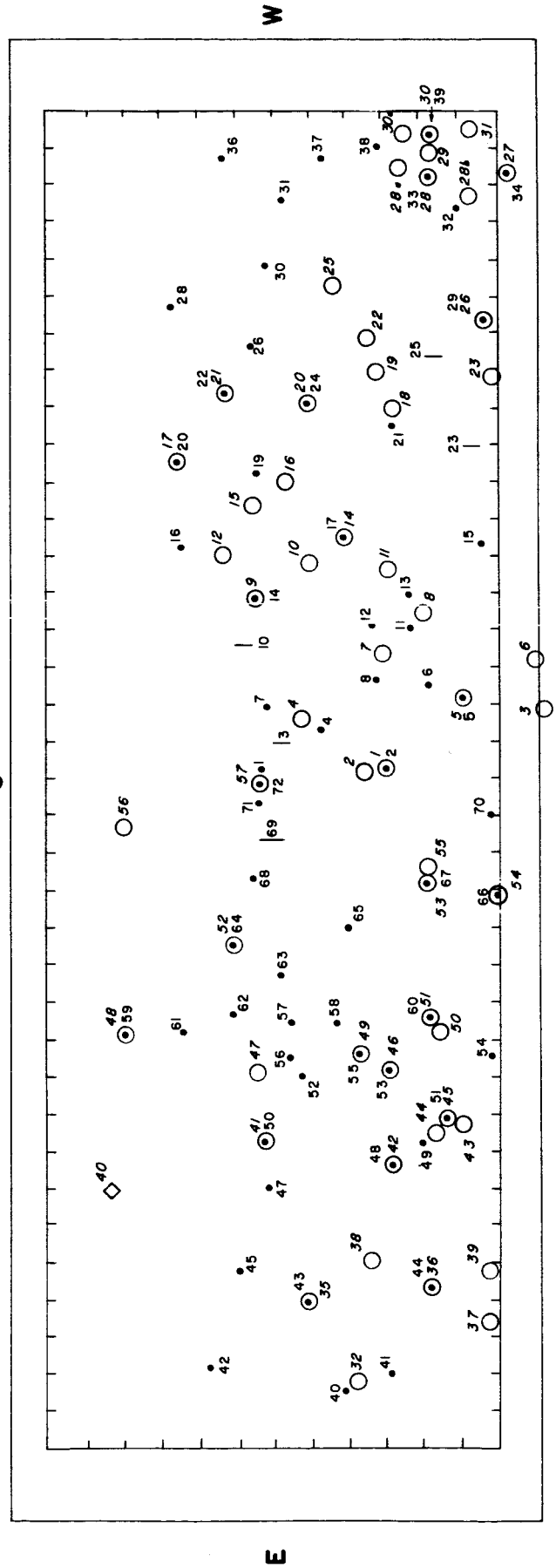

CERULLI AND DENNING - 1899


NUMBERS • GRAFF
ITALICS ○ ANTONIADI
LETTERS ⊡ LOWELL
S
E
W
1901




ITALICS ○ ◇ LOWELL

• | MOLESWORTH

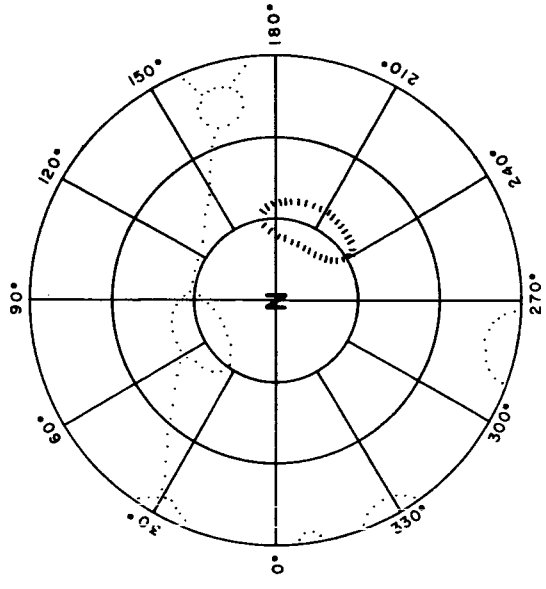


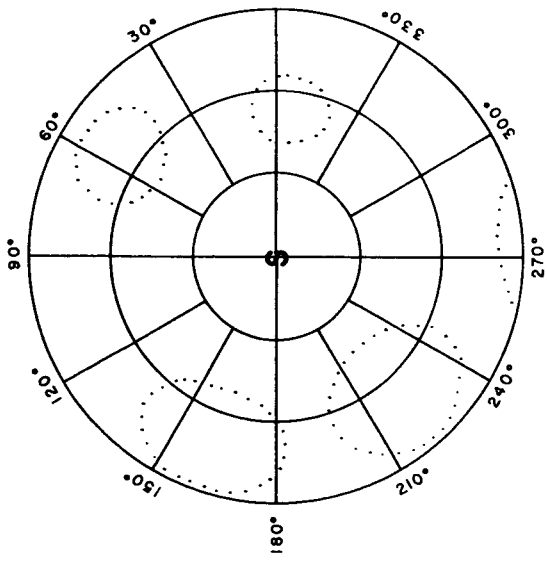
## IV. CROSS-INDICES

The points observed by the various astronomers at the various oppositions between 1877 and 1907 are related to each other in two ways in this section. Following the outline map appears a map indicating all the points recorded for the purpose of this study. Here, each point is identified by its key map number (KML), rather than by each observer's number.

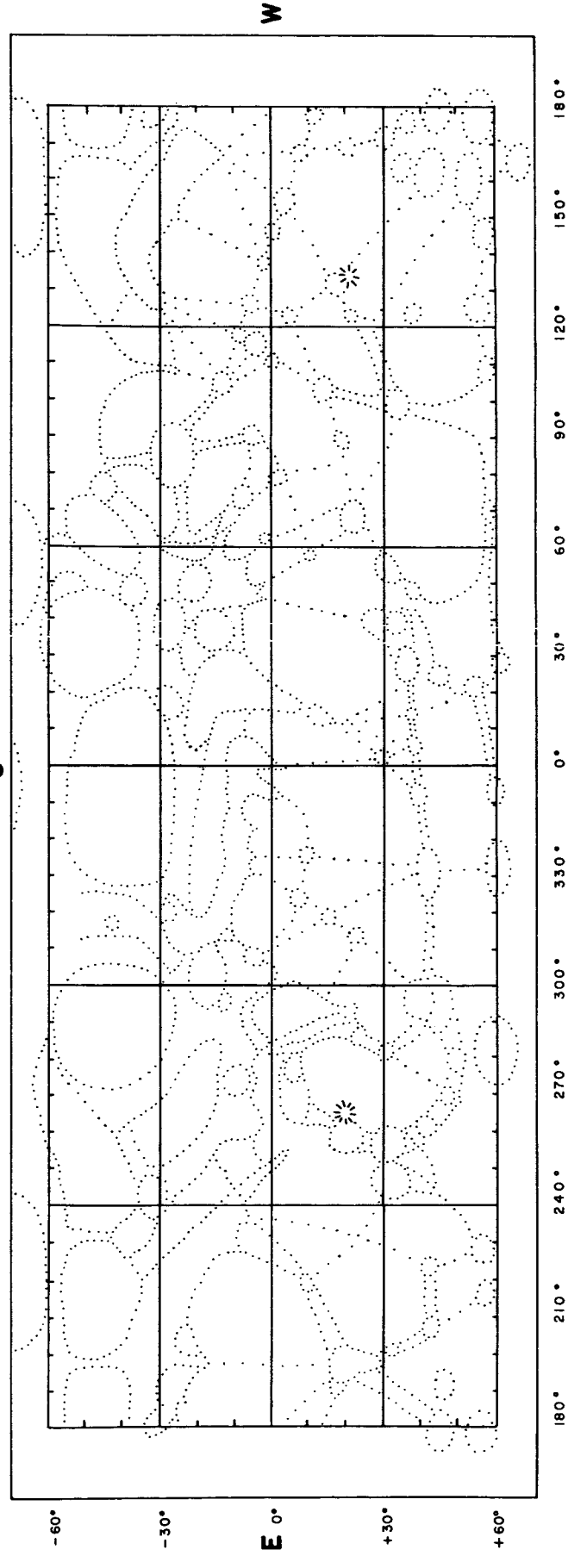
Following the maps, the tabular cross-index (Table 3) appears. The points are listed in consecutive order of KML number. By reading a column from top to bottom, one can see at once which KML points were reported by a single observer in a given year (e.g., under AN 03, all of Antoniadi's points used in this study are listed vertically). By reading across, one can see at a glance how many observers have measured the surface feature identified by a given KML number.

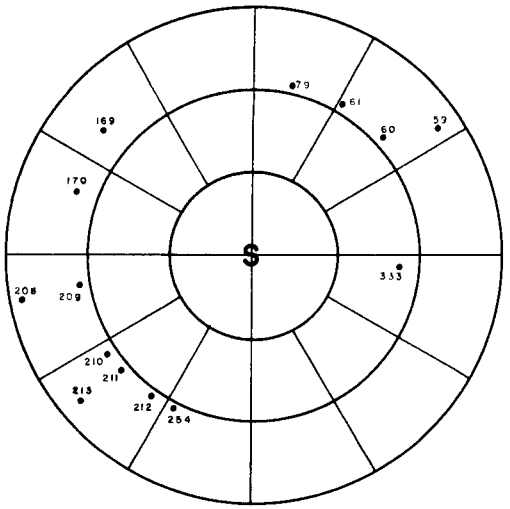
Table 4 relates the points recorded in this report (by KML number) to the points recorded in the preceding publication.[2]

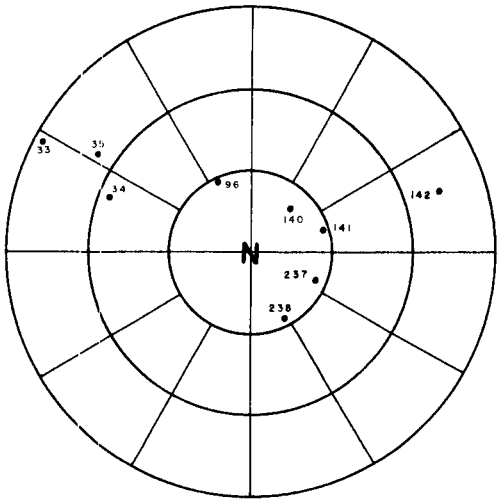



## OUTLINE MAP OF MARS



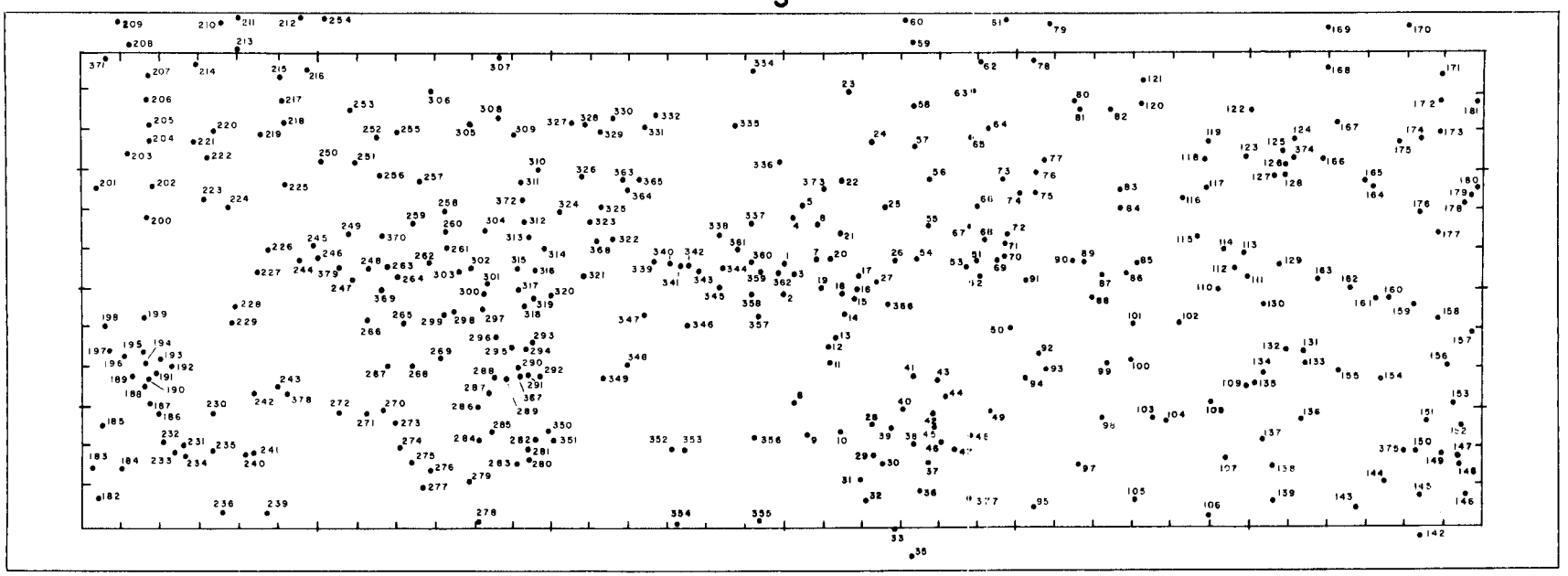



S

E

W



KEY MAP 1877-1907

Table 3

CROSS-IDENTIFICATION LIST OF POINTS 1877--1907

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | 1 | | | | | | | | | |
| 2 | | 2 | | | 2 | | 15 | | | | 2 | 2 | | 2 | | | | | |
| 3 | | | | | | | | | | | | | | | | | | 1 | |
| 4 | | | 30 | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | 3 | | | | | | | | |
| 6 | | | | | | | 17 | | | | | | | | | | | | |
| 7 | | | | | | | 16 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | 2 | | |
| 9 | | | | 2 | 5b | | | | | | | | 2 | | | | 1 | 2 | |
| 10 | | | | | | | | | | | | | 4 | | | | | | |
| 11 | | | | 5 | 5a | | | | | | | | | | | | | | |
| 12 | | | | | | | 18 | | | | | 3 | 3 | | | | | | |
| 13 | | | | | | | | | | | 4 | | | 6 | | | | 4 | |
| 14 | | 5 | | 7 | 5 | | | | 13 | 2 | | | | | | 3 | 4 | | |
| 15 | | | | | | | | | | | | | | 7 | | | | | |
| 16 | | | | | | 2 | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | 7 | |
| 18 | 2 | | | | | | | | | | | | | | | | | | |
| 19 | | 3 | | | | | | | | | | | | | | | | 3 | |
| 20 | | 4 | | | 4 | | | | | 12 | | | | 3 | | | | | |
| 21 | | | | 6 | | | | | | | | | | | | | | | |

Table 3 (Continued)

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | | | | | | | | | | | | | 5 | | | | | | |
| 23 | | | | | 8b | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | 4 | | | | | | | |
| 25 | | | | 4 | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | 6 | | | | | | | | |
| 27 | | 6 | 2 | | 6 | | 1 | | | | 5 | | | 8 | | | | | |
| 28 | | | | 8 | 5c | | | | | | | | | 4 | | | | 8 | |
| 29 | | | | | | | | | | | | | | 5 | | | | | |
| 30 | | | | | | | | | | | | | | | | | | 6 | |
| 31 | | | | | | | | | | | | | | | 1 | 2 | | | |
| 32 | | | | | | | | | | | | | 6 | | | | 5 | 5 | |
| 33 | | | | | | | | | | | | | | | | | | 9 | |
| 34 | | | | | | | | | | | | | | | | | 3 | | |
| 35 | | | | | | | | | | | | | | | | | 6 | | |
| 36 | | | | | | | | | 15 | | | | | 11 | | | | | |
| 37 | | | | | | 5 | | | | | | | | 11 | | | | | |
| 38 | | | | | | | | | | | | | | 10 | | | | | |
| 39 | | | | | | | | | | | | 6 | 7 | 9 | | | | | |
| 40 | | | 3 | | 6b | | | | | | | | | | | | | | |
| 41 | | | | | | | | | 14 | | | | | 9 | | | 7 | | |
| 42 | | | | | | | | | | | | | 9 | | | | | | |
| 43 | | | | | 7b | | | | | | | | | | | | | | |
| 44 | | | | | | | | | | | | | | | | | | 12 | |
| 45 | | | | | | | | | | | | | | 12 | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | | | | | | | | | | | | | | | | | | 11 | |
| 47 | | | | | | | | | | | | | | 13 | | | 8 | | |
| 48 | | | | | | | | | | | | | | | | | | 13 | |
| 49 | | | | | | | | | | | | | 13 | | | | 11 | | |
| 50 | | | | | | | | | | | | | 15 | | | | 10 | | |
| 51 | | | | | | | | | | | 7 | | | | | | | | |
| 52 | | 10 | | 13 | 10 | | | | | | | 8 | 10 | | | | 9 | 14 | |
| 53 | | | 4 | | 7a | | | | | | | (8) | (10) | | | | | | |
| 54 | | 7 | | 11 | 7 | | | | | 3 | | 7 | | | | | | 10 | |
| 55 | | | | | | | 2 | | | | | | | | | | | | |
| 56 | | | | | | | | | | | | | 8 | | | | | | |
| 57 | | 8 | | | 8 | | | | | | | | | | | | | | |
| 58 | | | | | 8a | | | | | 4 | | | | | | | | | |
| 59 | | | | | | | | | | | | 5 | | | | | | | |
| 60 | | | | 10 | | | | | | | | | | | | | | | |
| 61 | | | | | 9a | | | | | | | | | | | | | | |
| 62 | | 9 | | | | | | | | | | | | | | | | | |
| 63 | | | | | 9 | | | | | | | | | | | | | | |
| 64 | | | | 18 | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | 11 | | | | | | |
| 66 | | | | 14 | | | | | | | | | | | | | | | |
| 67 | | | | | | 4 | | | | | | | | | | | | | |
| 68 | | | | | | | | | 16 | | | | | | | | | | |
| 69 | | | | | | | | | | 5 | 8 | | | 15 | | | | | |
| 70 | | | | | | | | | 17 | | | | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71 | | | | | | | | | | | | | | 14 | | | | | |
| 72 | | | | 17 | | | | | | | | | 12 | | | | 12 | | |
| 73 | | 11 | | | 11 | | | | | | | | | | | | | | |
| 74 | | | 5 | | 11a | | | | | | | (9) | 14 | | | | | 16 | |
| 75 | | 12 | | | 12 | | | | | | | 9 | | | | | | | |
| 76 | | | | | | 7 | | | | | | | | | | | | | |
| 77 | | | | 22 | | | | | | | | | | | | | | | |
| 78 | | | | | | | | | | | | 10 | | | | | | | |
| 79 | | | | 15 | | | | | | | | | | | | | | | |
| 80 | | | | 20 | | | | | | | | | | | | | | | |
| 81 | | | | | | | | | | | | | 19 | | | | | | |
| 82 | | | | | 14a | | | | | | | | | | | | | | |
| 83 | 3 | 14 | 6 | 24 | 14 | 9 | 4 | | 18 | | 10 | 14 | 22 | 17 | | | 17 | 20 | |
| 84 | | | 7 | | | | | | | | | | | | | | | | |
| 85 | | | | | | | | | | | | | 23 | | | | | | |
| 86 | | | | | | | | | 19 | | | | | 18 | | | | | |
| 87 | | | | | | 8 | | | | | | 13 | | 18 | | | | 19 | |
| 88 | | | | | | | | | | | | | 21 | | | | 16 | | |
| 89 | | | | | 12b | | | | | | | | | | | | | | |
| 90 | | | | 21 | 12a | | | | | | | 12 | 17 | | | | 15 | | |
| 91 | | | | | | | | | | | | | 16 | | | | | | |
| 92 | | | | | 13a | | | | | | | | | | | | | | |
| 93 | | | | 16 | 13 | | | | | 6 | 9 | 11 | 18 | 16 | | | 14 | 17 | |
| 94 | | | | | | 6 | | | | | | | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | | | | | | | | | | | | | 20 | | | | | 15 | |
| 96 | | | | | | | | | | | | | | | | | 13 | 18 | |
| 97 | | | | | | | 3 | | | | | | | | | | | | |
| 98 | | | | 19 | | | | | | | | | | | | | | | |
| 99 | | 13 | | | | | | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | | 24 | | | | | | |
| 101 | | | | | | 10 | | | | | | | | | | | | | |
| 102 | | | | | | | | | | | | | 25 | | | | 20 | 24 | |
| 103 | | | | | | | | | | | | | | | | | | 21 | |
| 104 | | | | 25 | 13b | | | | | | | 17 | | 19 | | | 18 | | |
| 105 | | | | | | | | | | | | | | | | | | 23 | |
| 106 | | | | | | | | | | | | | | | | | 23 | | |
| 107 | | | | | | | | | | | | | | | | | | 25 | |
| 108 | | | | | | | | | | | | | | | | | 19 | | |
| 109 | | | | | | | | | | | | | | | | | 22 | | |
| 110 | | | | | | | | | | | | | 28 | | | | | | |
| 111 | | | | | | | | | | | | | 30 | | | | | | |
| 112 | | | | | | | | | | | | | | | | | | 26 | |
| 113 | | | | | | | | | | | | | 29 | | | | | | |
| 114 | | | | | | | | | 20 | | | | | | | | | | |
| 115 | | 15 | 9 | 28 | 15 | | | | | | 11 | 16 | 26 | | | | 21 | 22 | |
| 116 | | | 8 | | | | | | | | | | | | | | | | |
| 117 | | | | | 16a | | | | | | | | | | | | | | |
| 118 | | | | 27 | | | | | | | | | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 119 | | 16 | 10 | 26 | 16 | | | | | | | 18 | 27 | | | | | | |
| 120 | | | | | | | | | | | | 15 | | | | | | | |
| 121 | | | | 23 | | | | | | | | | | | | | | | |
| 122 | | 17 | | | 17 | | | | | | | | | | | | | | |
| 123 | | 18 | | | 18 | | | | | | | | | | | | | | |
| 124 | | 21 | | | 21 | | | | | | | | | | | | | | |
| 125 | | | | 29 | | | | | | | | | | | | | | | |
| 126 | | | | | | | | | | | | | 31 | | | | | 28 | |
| 127 | 4 | 19 | | 31 | 19 | | | | | | 12 | 19 | | | | | | | |
| 128 | | | | | 19a | | | | | | | | | | | | | | |
| 129 | | | | | 19b | | | | | | | | 32 | | | | | | |
| 130 | | | | | | | | | | | 14 | | 33 | | | | | | |
| 131 | | | | | | | | | | | 15 | | | | | | 25 | | |
| 132 | | | | 30 | | | | | | | | | | | | | | | |
| 133 | | | | | 19c | | | | | | | | | | | | | | |
| 134 | | | | | | | | | | | | | 34 | | | | | | |
| 135 | | | | | | | | | | | | | | | | | | 27 | |
| 136 | | | | | 19d | | | | | | | | | | | | | | |
| 137 | | | | | | | | | | | | | 35 | | | | | | |
| 138 | | | | | | | 5 | | | | | | | | | | | | |
| 139 | | | | | | | | | | | | | 36 | | | | 26 | 29 | |
| 140 | | | | | | | | | | | | | | | | | 24 | | |
| 141 | | | | | | | | | | | | | | | | | | 35 | |
| 142 | | | | | | | | | | | | | | | | | 27 | 34 | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 143 | | | | | | | | | | | | 23 | | | | | | | |
| 144 | | | | | | | | | | | | | | | | | | 32 | |
| 145 | | | | | 25b | | | | | | | | | | | | 28b | | |
| 146 | | | | | | | | | | | | | | | | | 31 | | |
| 147 | | | | | | | | | | | | | 48 | | | | 30 | | |
| 148 | | | | | | | | | | | | 24 | | | | | | | |
| 149 | | | | | | | | | | | | | | | | | 29 | | |
| 150 | | | | | | | | | | | | | | | | | 28 | 33 | |
| 151 | | | | | | | | | | | | | | | | | 28a | | |
| 152 | | | | | | | | | | | | | | | | | 30a | 39 | |
| 153 | | | | | | | | | | | | | 47 | | | | | 38 | |
| 154 | | | | | | | | | | | | | 41 | | | | | | |
| 155 | | | | | | | | | | | | | 38 | | | | | | |
| 156 | | | | | | | | | | | | | 46 | | | | | (38) | |
| 157 | | | | | | | | | | | | | 49 | | | | | | |
| 158 | | | | | | | | | | | | | 45 | 23 | | | | 37 | |
| 159 | | | | | | | | | | | | | 42 | | | | | | |
| 160 | | | 11 | | | | | | | | 18 | | | 21 | | | | 31 | |
| 161 | | | | | | | | | | | | | 39 | 21 | | | | | |
| 162 | | | | | | | | | | | 17 | | | | | | | | |
| 163 | | | | | | | | | | | 16 | 20 | 37 | | | | | 30 | |
| 164 | | | | | 25a | | | | | | | | 40 | | | | | | |
| 165 | | | | | | | | | | | 13 | | | | | | | | |
| 166 | | | | | | | | | | | | 21 | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 167 | | | | | 21a | | | | | | | 22 | | | | | | | |
| 168 | | | | | 21b | | | | | | | | | | | | | | |
| 169 | | 20 | | | 20 | | | | | | | | | | | | | | |
| 170 | | 22 | | | 22 | | | | | | | | | | | | | | |
| 171 | | | | | 24b | | | | | | | | | | | | | | |
| 172 | | | | | | | | | | | | 26 | | 25 | | | | | |
| 173 | | 24 | | | 24 | | | | | | | 26a | | | | | | | |
| 174 | | | | | 24a | | | | | | | 26a | | | | | | | |
| 175 | | 23 | | | 23 | | | | | | | | | | | | | | |
| 176 | | | | | | | | | | | | | 43 | | | | | | |
| 177 | 5 | 25 | 12 | 32 | 25 | 11 | | | | 7 | 19 | 25 | 44 | 24 | | | | 36 | |
| 178 | | 26 | | 33 | 26 | | | | | | | 28 | | | | | | | |
| 179 | | | 13 | | 26a | | | | | | | | | | | | | | |
| 180 | | | | 34 | 30a | | | | | | | | | | | | | | |
| 181 | | | | | | | | | | | | | | | | | | | |
| 182 | | | | | | | | | | | | | | 26 | | | | | |
| 183 | | | | | | | | | | | | 27 | | | | | | | |
| (184*) | | | | | | | | | | | | | | | | | | | |
| 185 | | | 14 | | | | | | | | | | | | | | | | |
| 186 | | | | | | | | | | | | | | | | | | 41 | |
| 187 | | | | | | | | | | | | | 54 | | | | | | |
| 188 | | | | | | | | 5 | | | | | | | | | | | |
| 189 | | | | | | | | | | | | 31 | 52 | | | | | | |
| 190 | | | | | | | | | | | | | | | | | 32 | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 191 | | | | | | | | | | | | 34 | | | | | | | |
| 192 | | | | | | | | | | | | 35 | 57 | | | | | | |
| 193 | | 33 | 15 | | | | | | | | | | | 29 | | | | | |
| 194 | | | | | 29 | | | | | | 21 | | | 28 | | 4 | | 40 | |
| 195 | | | | | | | | | | | | | 53 | | | | | | |
| 196 | | | | | | | | | | | | | | 27 | | | | | |
| 197 | | | | | | | | | | | | | 50 | | | | | | |
| 198 | | 28 | | | | | | | | | | | | | | | | | |
| 199 | | 29 | | | | | | | | | | | | | | | | | |
| 200 | | 30 | | | 30 | | | | | | | | 55 | | | | | 42 | |
| 201 | | | | | 30b | | | | | | | | | | | | | | |
| 202 | | | | | | | | | | | | 33 | | | | | | | |
| 203 | | | | | | | | | | | | 30 | | | | | | | |
| 204 | | | | | | | | | | | 20 | | | | | | | | |
| 205 | | | | | 31a | | | | | | | 36 | 51 | | | | | | |
| 206 | | 32 | | | | | | | | | | | | | | | | | |
| 207 | | 31 | | | 31 | | | | | | | 32 | | | | | | | |
| 208 | | | | | | | | | | | | (29) | | | | | | | |
| 209 | | 27 | | 35 | 27 | | | | | | | | | | | | | | |
| 210 | | | | 38 | | | | | | | | | | | | | | | |
| 211 | | 36 | | | | | | | | | | | | | | | | | |
| 212 | | | | 38a | | | | | | | | | | | | | | | |
| 213 | | 35 | | | | | | | | | | | | | | | | | |
| 214 | | | | 37 | | | | | | | | | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 215 | | 40 | | | 40 | | | | | | | | | | | | | | |
| 216 | | | | 37a | | | | | | | | | | | | | | | |
| 217 | | | | | | | | | | | | 40 | | | | | | | |
| 218 | | | | | 40a | | | | | | | | | | | | | | |
| 219 | 6 | 38 | 16 | 36 | 38 | | | | | | | | | | | | | | |
| 220 | | 34 | | | 34 | | | | | | | | | | | | | | |
| 221 | | | | | | | | | | | 26 | | | | | | | | |
| 222 | | | | | | | | | | | 25 | | | | | | | | |
| 223 | | | | | | | | | | | 22 | | | | | | | | |
| 224 | | | | | | | | | | | 23 | | | | | | | | |
| 225 | | 39 | | | | | | | | | | | | | | | | | |
| 226 | | 37 | | | 37b | | | | | | | | | | | | | 45 | |
| 227 | | | | | | | | | | | | 39 | | | | | | | |
| 228 | | | | | | | | 7 | | | | | | | | | | | |
| 229 | | | | | | | | | | | | 38 | 58 | 30 | | 6 | 35 | 43 | |
| 230 | | | | | | 12 | 6 | | | | | | | | | | | | |
| 231 | | | | | 29b | | | | | | | | | | | | | | |
| 232 | | | | | | | | | | | | | | | | | | | |
| 233 | | | | | 29a | | | | | | | | | | | | | | |
| 234 | | | | | | | | | | | | | 56 | | | 5 | | | |
| 235 | | | | | | | | | | | | 37 | | | | | | | |
| 236 | | | | | | | | | | | | | | | | | 37 | | |
| 237 | | | | | | | | | | | | | | | | | 33 | | |
| 238 | | | | | | | | | | | | | | | | | | 46 | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 239 | | | | | | | | | | | | | | | | | 39 | | |
| 240 | | | | | | | | | | | | | | | | 7 | 36 | 44 | |
| 241 | | | | | 43a | | | | | | | | | | | | | | |
| 242 | | | | | | | | 6 | | | | 42 | | | | | | | |
| 243 | | | | | | | | | | | | | 59 | | | | 38 | | |
| 244 | | | | | 37a | | | | | | 24 | 41 | | | | | | | |
| 245 | | | | | | | | | | | | | 60 | | | | | | |
| 246 | 7 | 41 | 17 | | 41 | 13 | | | | | | | | 31 | | | (41) | 47 | |
| 247 | | | | | | | | | | | | 43 | | | | | | | |
| 248 | | | 18 | | 42 | | | | | | | | | | | | | | |
| 249 | | 42 | | | | | | | | | | | | | | | | | |
| 250 | | | | | | | | | | | | | 61 | | | | | | |
| 251 | | | | 57 | | | | | | | | | | | | | | | |
| 252 | | | | 40 | | | | | | | | | | | | | 40 | | |
| 253 | | | | | | | | | | | 27 | | | | | | | | |
| 254 | | | | | 36a | | | | | | | | | | | | | | |
| 255 | | | | | 45a | | | | | | | | | | | | | | |
| 256 | | | | | | | | | | | | 44 | 65 | | | | | | |
| 257 | | 45 | | | | | | | | | | | | | | | | | |
| 258 | | | | | | | | 9 | | | | | | | | | | | |
| 259 | | 44 | | | 44 | | | | | | | | | | | | | | |
| 260 | | | | | | | | | | | | 48 | | | | | | | |
| 261 | | | | | | | | | | | | | 66 | | | | | | |
| 262 | | | | | | | | | | | 28 | | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 263 | 8 | 43 | | | | | | | | | | | | | | | | | |
| 264 | | | 20 | 42 | 43 | 14 | 8 | | | | | 47 | 64 | 33 | 2 | | 41 | 50 | |
| 265 | | | | | | 15 | | | | | | | | | | | | | |
| 266 | | | 19 | | | | | | | | | | | | | | | | |
| 267 | | 46 | | | 46 | | | | | | | | | | | 9 | | | |
| 268 | | | | | 46a | | | | | | | | | | | | | | |
| 269 | | | | | | | | 3 | | | | | | | | | | | |
| 270 | | | | | 46b | | | | | | | 46 | 63 | 32 | | | 42 | 48 | |
| 271 | | | | | 46c | | | | | | | 45 | | | | | | | |
| 272 | | | | 39 | 41a | | | | | | | | | | | | | | |
| 273 | | | | | | | 7 | | | | | | | | | | | | |
| 274 | | | | | | | | | | | | | 62 | 32 | | | | 49 | |
| 275 | | | | | | | | | | | | | | | | | 44 | | |
| 276 | | | | | | | | | | | | | | | | | 45 | 51 | |
| 277 | | | | | | | | | | | | | | | | | 43 | | |
| 278 | | | | | | | | | | | | | | | 3 | | | 54 | |
| 279 | | | | | | | | | | | | | 67 | | | | | | |
| 280 | | | | | | | | 2 | | | | 52 | 72 | | | | | | |
| 281 | | | 26 | | | | | | | | | | | | | | | | |
| 282 | | | | | | | | | | | | | | | 6 | 11 | 51 | 60 | |
| 283 | | | | | | | | | | | | | | | | | 50 | | |
| 284 | | | | | | 18 | | | | | | | | | | | | | |
| 285 | | | 21 | 45 | 51c | | | | | | | | | | | | | | |
| 286 | | | 21 | | | | | | | | | | 68 | | | | 46 | 53 | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 287 | | | | 47 | | | | | | 9 | | | | | | | | 55 | |
| 288 | | | | | | | | | | 9 | 30 | 50 | | | | | | | |
| 289 | | 50 | | | | | | | | | | | | 35 | 4 | 10 | 49 | | |
| 290 | 9 | | | | (51a) | | | | | | | | 70 | | | | | | |
| 291 | | | | | 51b | | | | | | | | | | | | | | |
| 292 | | | | | | | 10 | | | | | | | | | | | | |
| 293 | | | | | | | | | | | | | | | 5 | | | 58 | |
| 294 | | 51 | | | | | | | | | | | | | | | | | |
| 295 | | | | | | | 19 | 1 | 1 | | | | | | | | | | |
| 296 | | | | 46 | 50a | | | | | | | | | | | | | | |
| 297 | | | | | | | | | | | | 49 | 69 | | | | | | |
| 298 | | 48 | | | 48 | | | | | | | | | 34 | | | | 52 | |
| 299 | | | | | | 16 | | | | | | | | | | | | | |
| 300 | | | | | | | | | | | | | | | | | | 56 | |
| 301 | | | 22 | | | | | | | | | | | | | | | | |
| 302 | | | | | | | | | | | 29 | | | | | | 47 | | |
| 303 | | | | 43 | | | | | | | | | | | | | | | |
| 304 | | 49 | 23 | 48 | 49 | | | | | | | | | | | | | | |
| 305 | | | | 49b | 47a | | | | | | | | | | | | | | |
| 306 | | 47 | | | | | | | | | | | | | | | | | |
| 307 | | 52 | | | | | | | | | | | | | | | | | |
| 308 | | | | | 53 | | | | | | | | | | | | | | |
| 309 | | 53 | 27 | 49 | | | | | | 8 | | | | | | | 48 | 59 | |
| 310 | | | | | | | | | | | 31 | | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 311 | | 54 | | 49a | 54 | | | | | | | 51 | | | | | | 61 | |
| 312 | | | | 44 | | | | | | | | | | | | | | | |
| 313 | | | | | | | | | | | | 53 | | | | | | 62 | |
| 314 | | | | | | 20 | | | | | | | | | | | | | |
| 315 | | | | | | | | 4 | | | | | | | | | | | |
| 316 | | | 25 | | | | | | | | | | | | | | | | |
| 317 | | | | | | | | | | | | | 71 | | | | | | |
| 318 | | | 24 | | | 19 | | | | | | | | | | | | | |
| 319 | | | | | | | | | | | | | | | | | | 57 | |
| 320 | | 55 | | 50 | 55 | | 11 | | | | | | | | | | | | |
| 321 | | | | | 57a | | | | | | | 54 | 73 | | | | | 63 | |
| 322 | | 57 | 28 | 52 | 57 | 21 | | | 10 | 11 | 32 | | 76 | 37 | 7 | 12 | 52 | 64 | |
| 323 | | | | 51 | | | | | | | | | | | | | | | |
| 324 | | | | | | | | | | | | | | | | | | | |
| 325 | | 58 | | | | | | | | | | | | | | | | | |
| 326 | | | | | | | | | | | | 56 | 75 | | | | | | |
| 327 | | 56 | | (49c) | 56a | | | | | 10 | | | | 36 | | | | | |
| 328 | | | | | | | | | | | | | | | | | | | |
| 329 | | | | | | | | | | | | 57 | | | | | | | |
| 330 | | 59 | | | | | | | | | | | | | | | | | |
| 331 | | | | 49c | | | | | | | | | | | | | | | |
| 332 | | 60 | | | | | | | | | | | | | | | | | |
| 333 | | | | | 59a | | | | | | | | | | | | | | |
| 334 | | | | | | | | | | | | 60 | | | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 335 | | | | | 60a | | | | | | | | | | | | 56 | | |
| 336 | | | | 3 | | | | | | | | | | | | | | | |
| 337 | | | 31 | | | | | | | | | | | | | | | | |
| 338 | | | 29 | 55 | | | | | | | | | | | | | | | |
| 339 | | | | | | | 12 | | | | | | | | | | | | |
| 340 | | | | | 61 | | | | | | 33 | 58 | 79 | 38 | 8 | 13 | | 68 | |
| 341 | | | | | | | | | | | 34 | | | | | | | | |
| 342 | | | | | 61c | | | | | | 35 | 58 | 79 | 40 | 8 | 13 | | 68 | |
| 343 | | 61 | | | | | | | | | | | | | | | | | |
| 344 | | | | | 62a | | | | | | | | | | | | | | |
| 345 | | | | | | | | | | | | | | | | | | 69 | |
| 346 | | | | | 61d | | | | | | | | 78 | | | | | | |
| 347 | | | | | 57b | | | | | | | | | | | | | | |
| 348 | | | | | | | | | | | | | | | | | | 65 | |
| 349 | | | | | | | | | | | | | 74 | | | | | | |
| 350 | | | | | 61a | | | | | | | | | | | | | | |
| 351 | | | | | 61b | | | | | | | | | | | | | | |
| 352 | | | | | 61e | | | | | | | 59 | 80 | 39 | 9 | 14 | 53 | 67 | |
| 353 | | | | | | | | | | | | | | | | | 55 | | |
| 354 | | | | | | | | | | | | | 81 | | | | 54 | 66 | |
| 355 | | | | | | | | | | | | | | | | | | 70 | |
| 356 | | | | | | | | | | | | | 82 | | | | | | |
| 357 | | | | | | | | | 11 | | | | | | | | | | |
| 358 | | 62 | | 54 | 62 | | 13 | | | | | 1 | | 1 | | | | | |

| KML No. | BK 77 | SC 77 | BU 79 | NI 79 | SC 79 | NI 81 | LH 84 | WS 88 | WS 90 | WL 92 | LW 94 | CE 96 | LW 96 | CE 99 | AN 01 | GR 01 | LW 03 | MO 03 | AN 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 359 | | | | | | | | | | | | | | | | | | 71 | |
| 360 | | | | | | | | | | | 36 | | | | | | | | |
| 361 | | | | | 62b | | | | | | | | | | | | | | |
| 362 | | 1 | 1 | 1 | 1 | 1 | 14 | | | | 1 | 1a | 1 | 2a | | 1 | 57 | 72 | |
| 363 | | | | | | | | | | | | | 77 | | | | | | |
| 364 | | | | | 58 | | | | | | | | | | | | | | |
| 365 | | | | | | | | | 9 | | | | | | | | | | |
| 366 | | | | | 6a | | | | | | | | | | | | | | |
| 367 | | | | | 51a | | | | | | | | | | | | | | |
| 368 | | | | | | | | | | | | 55 | | | | | | | |
| 369 | | | | | | | | | | | | | | | | 8 | | | |
| 370 | | | | 41 | | | | | | | | | | | | | | | |
| 371 | | | | | | | | | | | | 29 | | | | | | | |
| 372 | | | | | | | | | 8 | | | | | | | | | | |
| 373 | | | | | | | | | 12 | | | | | | | | | | |
| 374 | | | | | | | | | | | | | | 20 | | | | | |
| 375 | | | | | | | | | | | | | | 22 | | | | | |

| KML No. | WN 77 | LH 79 | DE 84 | KN 84 | LH 86-8 | SC 86-8 | LH 92 | PI 92 | DE 99 | LW 01 |
|---|---|---|---|---|---|---|---|---|---|---|
| 14 | | | | | | | | 1 | | |
| 83 | | 1 | | 1 | | | | | | |
| 102 | | | | | | | | | | B |
| 147 | | | | | | | | | | D |
| 150 | | | | | | | | | | C |
| 177 | | 2 | | | | | | | | |
| 184 | | | | | | | | | | E |
| 263 | | 3 | | | | | | | | |
| 264 | | 3 | | | | | | | | |
| 288 | | | | 2 | | | | | | |
| 290 | 1 | 4 | | | | | | | | |
| 295 | | | 1 | | 1 | | | | 1 | |
| 352 | | | | | | 2 | | | | |
| 362 | | | | | | 1 | 1 | | | A |

Table 4

IDENTIFICATION LIST KML - VML (PML)

| KML | VML (PML) | KML | VML (PML) | KML | VML (PML) |
|---|---|---|---|---|---|
| 1 | 195? | 35 | - | 67 | - |
| 2 | 2 | 36 | 286W | 68 | 154 |
| 3 | - | 37 | - | 69 | 16? |
| 4 | - | 38 | 228 | 70 | 16? |
| 5 | 303 | 39 | 226x | 71 | 192 |
| 6 | 86x | 40 | 87x | 72 | 18 |
| 7 | 115 | 41 | 7x | 73 | - |
| 8 | P231 | 42 | 227 | 74 | 88x |
| 9 | 150 | 43 | 289x | 75 | 296 |
| 10 | - | 44 | - | 76 | - |
| 11 | - | 45 | 223 | 77 | P286 |
| 12 | P 11x | 46 | 8x | 78 | P 41x |
| 13 | 3 | | 230x | 79 | - |
| 14 | 5 | 47 | 119x | 80 | - |
| 15 | - | 48 | - | 81 | - |
| 16 | - | 49 | P 36x | 82 | - |
| 17 | 153x | | P278x | 83 | 157x |
| 18 | 152? | 50 | - | 84 | - |
| 19 | - | 51 | 229 | 85 | 90 |
| 20 | 151 | 52 | 15x | 86 | - |
| 21 | - | 53 | 15x | 87 | 21 |
| 22 | P 14 | 54 | 11 | 88 | P289 |
| 23 | - | 55 | P 6 | 89 | - |
| 24 | 215x | 56 | 12 | 90 | 89 |
| 25 | - | 57 | 10 | 91 | 20 |
| 26 | 118? | 58 | 9 | 92 | - |
| 27 | - | 59 | 216 | 93 | 19 |
| 28 | 281x | 60 | - | 94 | - |
| 29 | - | 61 | 17 | 95 | - |
| 30 | - | 62 | 155 | 96 | - |
| 31 | - | 63 | 218 | 97 | - |
| 32 | 286E | 64 | - | 98 | - |
| 33 | - | 65 | P 34 | 99 | - |
| 34 | - | 66 | - | 100 | - |

Table 4 (Continued)

| KML | VML (PML) | KML | VML (PML) | KML | VML (PML) |
|---|---|---|---|---|---|
| 101 | - | 136 | - | 171 | 94 |
| 102 | 23x | 137 | - | 172 | 161 |
| 103 | - | 138 | - | 173 | 108 |
| 104 | 125 | 139 | 27x | 174 | - |
| 105 | 123? | 140 | - | 175 | 179 |
| 106 | - | 141 | - | 176 | - |
| 107 | - | 142 | 33 | 177 | 34 |
| 108 | - | 143 | 251 | 178 | 37 |
| 109 | P 73 | 144 | 130x | 179 | 180 |
| 110 | - | 145 | 250 | 180 | - |
| 111 | P 75? | 146 | 36 | 181 | - |
| 112 | 91 | 147 | 38 | 182 | - |
| 113 | - | 148 | - | 183 | - |
| 114 | - | 149 | - | 184 | - |
| 115 | 25 | 150 | 132 | 185 | - |
| 116 | - | 151 | - | 186 | - |
| 117 | P303 | 152 | - | 187 | P124 |
| 118 | - | 153 | 254 | 188 | - |
| 119 | - | 154 | - | 189 | P329? |
| 120 | 24 | 155 | - | 190 | - |
| 121 | - | 156 | P323 | 191 | - |
| 122 | 233 | 157 | - | 192 | 211 |
| 123 | - | 158 | P104 | 193 | - |
| 124 | 198 | 159 | - | 194 | 43 |
| 125 | - | 160 | 255 | 195 | - |
| 126 | 274 | 161 | P 96? | 196 | - |
| 127 | 29? | 162 | P313? | 197 | 203x |
| 128 | 29? | 163 | 269 | 198 | - |
| 129 | 267 | 164 | 30x | 199 | - |
| 130 | - | 165 | - | 200 | 44 |
| 131 | 92 | 166 | 159x | 201 | 63? |
| 132 | - | 167 | 93 | | 209? |
| 133 | 28 | 168 | P 94 | 202 | - |
| 134 | - | 169 | 298 | 203 | - |
| 135 | P309x | 170 | 31 | 204 | - |

Table 4 (Continued)

| KML | VML (PML) | KML | VML (PML) | KML | VML (PML) |
|---|---|---|---|---|---|
| 205 | 42 | 239 | 199 | 273 | P387? |
| 206 | 166 | 240 | 51 | 274 | - |
| 207 | 235 | 241 | - | 275 | - |
| 208 | 40 | 242 | - | 276 | 252? |
| 209 | 41 | 243 | 138x | 277 | - |
| 210 | - | | 53x | 278 | 66 |
| 211 | 49 | 244 | 189 | 279 | P160 |
| 212 | - | 245 | - | 280 | 244? |
| 213 | - | 246 | 278 | 281 | 244? |
| 214 | - | 247 | 55 | 282 | 71x |
| 215 | 257 | 248 | 213 | 283 | - |
| 216 | - | 249 | 54x | 284 | - |
| 217 | 169 | 250 | - | 285 | - |
| 218 | 52 | 251 | - | 286 | 242 |
| 219 | 50 | 252 | - | 287 | 290 |
| 220 | - | 253 | - | 288 | 240? |
| 221 | - | 254 | 299 | 289 | 67 |
| 222 | 275? | 255 | 60 | 290 | - |
| 223 | 167 | 256 | - | 291 | 69 |
| 224 | - | 257 | - | 292 | 200x |
| 225 | - | 258 | - | 293 | - |
| 226 | 48 | 259 | - | 294 | - |
| 227 | - | 260 | P396 | 295 | - |
| 228 | - | 261 | P158 | 296 | - |
| 229 | 47 | 262 | 104 | 297 | 103x |
| 230 | - | 263 | - | 298 | 261 |
| 231 | - | 264 | 58 | 299 | 279x |
| 232 | - | 265 | - | 300 | - |
| 233 | - | 266 | - | 301 | 143 |
| 234 | 45 | 267 | 96 | 302 | P164x |
| 235 | 136? | 268 | - | 303 | P159x |
| | 258? | 269 | - | 304 | 102 |
| 236 | 135x | 270 | 59 | 305 | - |
| 237 | - | 271 | P372? | 306 | P163x |
| 238 | - | 272 | 300 | 307 | 99 |

Table 4 (Continued)

| KML | VML (PML) | KML | VML (PML) |
|---|---|---|---|
| 308 | 101 | 342 | 176 |
| 309 | 68 | 343 | - |
| 310 | - | 344 | 265 |
| 311 | 70 | 345 | - |
| 312 | - | 346 | 82 |
| 313 | 73x | 347 | 76 |
| 314 | P183? | 348 | - |
| 315 | 105x | 349 | 74x |
| 316 | - | 350 | - |
| 317 | P173? | 351 | - |
| 318 | - | 352 | 79 |
| 319 | - | 353 | 292 |
| 320 | 72 | 354 | 80 |
| 321 | 245 | 355 | - |
| 322 | 145 | 356 | P227 |
| 323 | - | 357 | - |
| 324 | - | 358 | 85 |
| 325 | P198 | 359 | - |
| 326 | - | 360 | 114x |
| 327 | 243x | | P220 |
| | 100x | 361 | - |
| 328 | P196 | 362 | 1? |
| 329 | P200 | 363 | - |
| 330 | - | 364 | 147? |
| 331 | 146? | 365 | 246 |
| 332 | - | 366 | - |
| 333 | P 9x | 367 | - |
| 334 | 249 | 368 | 75x |
| 335 | 84x | 369 | - |
| 336 | - | 370 | P378 |
| 337 | - | 371 | - |
| 338 | - | 372 | 73? |
| 339 | - | 373 | 273? |
| 340 | 175 | 374 | - |
| 341 | 81 | 375 | P318 |

? uncertainty in identification

x approximate correspondence only

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